The Difference between Islamic and Conventional Banking: A Basic Macroeconomic Approach

Inaugural-Dissertation
zur Erlangung des akademischen Grades eines
Doktors der Wirtschafts- und Sozialwissenschaften
der Wirtschafts- und Sozialwissenschaftlichen Fakultät
der Christian-Albrechts-Universität zu Kiel

vorgelegt von
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Hamburg, 2022

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Tag der mündlichen Prüfung: 1. Februar 2023

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List of Acronyms

BR	Bounded Rationality
CES	Constant Elasticity of Substitution
CO	Company
D	Demand
DSGE	Dynamic Stochastic General Equilibrium
ECB	European Central Bank
EQ	Equilibrium
FOC	First-Order Condition
GOV	Government
HH	Household
IB	Islamic Commercial Bank
ICB	Islamic Central Bank
INV	Investment
IRF	Impulse Response Function
IS	Investment-Saving
MEC	Marginal Efficiency of Capital
NB	Non-Bank
NKIBM	New Keynesian Islamic Banking Model
NKM	New Keynesian Macroeconomics
PC	Phillips Curve
Q	Specific Point in the Graph
R	Rationality
S	Supply
SAV	Saving
SINU	Stock in Non-Separable Utility

List of Symbols

A	stocks
$\alpha(\cdot)$	share of D_{INV} in comparison to D_{SAV} (coefficient)
α	fraction of rational agents
$a(\cdot)$	credit supply coefficient
$\overline{A}$	constant stock supply
a_i	semi-elasticities of money supply
α_i	utility weight
A^+	real capital
$\overline{A^+}$	constant real capital
A^D	stock demand
$A^{+,D}$	real capital demand
A^D_{IB}	stock demand of Islamic commercial banks
A^S	stock supply
$A^{+,S}$	real capital supply
A_{HH}	stocks possessed by households
A^+_{HH}	real capital possessed by households
A_{IB}	stocks possessed by Islamic commercial banks
A^+_{IB}	real capital possessed by Islamic commercial banks
A_{ICB}	stocks possessed by Islamic central banks
A^+_{ICB}	real capital possessed by Islamic central banks
B	bond market
$b(\cdot)$	stock demand coefficient
β	discount factor
B_m	monetary base
b^m	logarithmized monetary base
B^x_m	exogenous monetary base
B_{GOV}	government issued Islamic bonds held by the Islamic central bank
C	consumption
c_i	semi-elasticity of goods demand
C^{NB}	cash in circulation
c^{NB}	cash ratio
CP_0	initial cost of purchase for the investment
Δ	determinant of the matrix system
δ	slope of the Phillips curve
D_{INV}	investment account/deposit

D_{SAV}	savings account/deposit
Div	dividend distributed by companies
E	expectation operator
e	return on stocks expressed as dividend yield
ϵ	elasticity
$\overline{e_0}$	steady state return on stocks rate
e^e	expected return on stocks
E^n	net return of the available real capital
ϵ_k	credit shock
ϵ^k	logarithmized credit shock
ϵ_π	cost-push shock
ϵ^π	logarithmized cost-push shock
ϵ_y	demand shock
ϵ^y	logarithmized demand shock
η	inverse of the Frisch elasticity of labor supply
η^y	logarithmized inverse of the Frisch elasticity of labor supply
ER	excess reserves
$f^D(\cdot)$	stock demand coefficient
$f^{+,D}(\cdot)$	real capital coefficient
$f^S(\cdot)$	stock supply coefficient
$f^{+,S}(\cdot)$	real capital supply coefficient
G	government expenditure
I	investment
i	interest rate
i_B	interest rate on bonds
$i_{B_{GOV}}$	interest rate on government issued bonds
i_L	interest rate on loan
I_τ	complete information set
K	credits to non-banking sector
k	logarithmized credits to non-banking sector
$\overline{K}$	sum of credits under rationing
K^D	credit demand
k^D	logarithmized credit demand
$k^D(\cdot)$	credit demand coefficient
$\overline{K^D}$	demand-side credit rationing
K^S	credit supply
k^S	logarithmized credit supply
$k^S(\cdot)$	credit supply coefficient
$\overline{K^S}$	supply-side rationing

$\mathcal{L}$	Lagrange function
l_i	semi-elasticity of credit demand
λ	Lagrange multiplier/shadow price
M	money aggregate
M^+	extended money aggregate
M^D	money demand
m^D	logarithmized money demand
$m^D(\cdot)$	money demand coefficient
m^r	real money demand
M^S	money supply
m^S	logarithmized money supply
$m^S(\cdot)$	money supply coefficient
N	labor
$\mathcal{N}$	normally distributed
Ω	Calvo degree of price stickiness
NPV	net present value
π	logaritmized inflation rate
π^e	expected inflation rate
π^T	inflation rate target
P	price level
P_A	stock price
P_A^+	price of real capital
Q	equilibrium/disequilibrium
q	Tobin's q
$\overline{Q}$	point of rest under rationing
q_i	semi-elasticity of money demand
R	marginal efficiency of capital
r	return on existing real capital
r_i	*semi*-elasticities of the loan supply
ρ	general risk parameter of the market
ρ_A	risk parameter of the stock market
$\rho_{B_{GOV}}$	risk parameter of the bond market
ρ_K	risk parameter of the credit market
S	credit that the ICB lends to the Islamic commercial bank
s	logarithmized credit that the ICB lends to the Islamic commercial bank
σ	inverse of the intertemporal substitution elasticity between present and future consumption
σ_y	standard error

T	total tax amount (in sum)
t	tax rate (in the interval between 0 and 1)
$\overline{t_0}$	steady state tax on cash rate
τ	time parameter
ϑ	adaption parameter in heuristics
t^e	expected tax rate (in the interval between 0 and 1)
T_{ER}	tax levied on excess reserves (in sum)
t_{ER}	tax levied on excess reserves (in the interval between 0 and 1)
T_{SAV}	tax levied on saving accounts (in sum)
t_{SAV}	tax levied on saving accounts (in the interval between 0 and 1)
U	utility
v	inverse of the elasticity of intratemporal substitution
φ	autocorrelation coefficient
W	wealth
w	nominal wage rate
x	output gap
X_i	Euler equation coefficient
Ξ	CES-index of consumption
Y	national income
y	logarithmized output/national income
y^*	potential output/national income
$y(\cdot)$	IS coefficient
Y^D	goods demand
$Y^{D,A}$	aggregated goods demand (of high-income and low-income non-banks)
$Y^{D,H}$	goods demand of high-income non-banks
$y^{D,H}(\cdot)$	goods demand coefficient of high-income non-banks
$Y^{D,L}$	goods demand of low-income non-banks
$y^{D,L}(\cdot)$	goods demand coefficient of low-income non-banks
y^e	expected output/national income
Y^S	goods supply
z	interest on excess reserves

Glossary

This section explains some Arabic words and terms occurring in the monograph. The Arabic terms are written in a non-standardized phonetic script, making it easier for the non-Arabic reader to read these terms.

bay al-dayn	sale of debt
bay al-inah	sale with immediate repurchase
gharar	uncertainty
hadith	sayings of the prophet of Islam
halal	religiously permitted
hibah	gift or premium
ibadah	worship of god
ijma	general agreement among Islamic scholars
istisna	manufacture sale
mayseer	gambling
muamalat	behavior of daily life
mudarabah	trust financing
mudarib	an entrepreneur that is in need of financial capital
murabaha	cost-plus or credit sale
musharakah	partnership contract
qard hassan	"good loan" that is in favor of low-income households
Quran	holy book of Muslims
rab al-mal	financier
riba	an excess charged on loans
salam	forward sale
sarf	sale of currency
shariah	Islamic canonical law
sukuk	Islamic securities (bonds)
sunnah	deeds and sayings of the prophet of Islam
takaful	Islamic insurance
tawarruq	cash finance
tawriq	securitization
usr	ease/convenience
wadi'ah	current account
zakat	a kind of wealth tax (lit. meaning: purification)

Acknowledgements

I am indebted and, at the same time, incredibly grateful to Prof. Dr. Hans-Werner Wohltmann that he shared my vision of a macroeconomic Islamic banking model from the very beginning. His patience, advice, warmth, and kindness as my supervisor carried me through our years of collaboration and made me the economist I am today.

Another special companion on my academic journey has been Nils Müller. His suggestions and support were an enrichment for me, especially in the final phase of the dissertation. Our lengthy walks on campus, especially on numerous weekends, provided much food for reflection. When I think back to that time, it fills my heart with gratitude.

Furthermore, the impulses from Felix Gelhaar, Norman Liebke, Shayan Ahmed, and Thilo Kröger, who provided me with advice and support, were extraordinarily precious. I also thank them from the bottom of my heart.

I am indebted to my parents, Umtul Hafiz and Nooruddin, who have always believed in me and supported me, especially through their countless prayers. My sons Kamil and Jakub always taught me not to lose the lightness in life when it became serious. Without knowing it, they were there for me. Thanks, guys.

I dedicate this work to my beloved wife, Nadia.

Hamburg, November 2022 — Tariq Chaudhry

1 Introduction

Financial crises seem to repeat as can be seen by historical data about the financial system. The available figures go back to the early 19th century. The Panic of 1825 and the Wall Street Crash (1929) followed by the "Great Depression" or the Asian Crisis of 1997 are examples of suddenly collapsing financial assets or institutions. Looking at the long list of such incidents, it is clear that not only developed countries suffer. All countries integrated into financial system feel the effects of a collapse on their real economy, leaving the affected society with multiple problems (tightening of credits, decreasing economic productivity, increasing unemployment). Similar developments were apparent in the aftermath of the global financial crisis of 2007-2008, which was rooted in the US sub-prime crisis and gripped all important financial places worldwide quickly.

Particularly, the aftermath of the global financial crisis of 2007-2008, new approaches to banking have been on the rise. Many vocal critics held the view that the interest-based system has proven to be a destabilizing factor in the international financial system.

Among the critics, some experts brought up past thinkers such as Hyman Minsky with his famous "Financial Instability Hypothesis"[1], but among the present economists (i.e., Mian and Sufi (2014)) there were warnings against the unsustainability of debt-based banking, too.

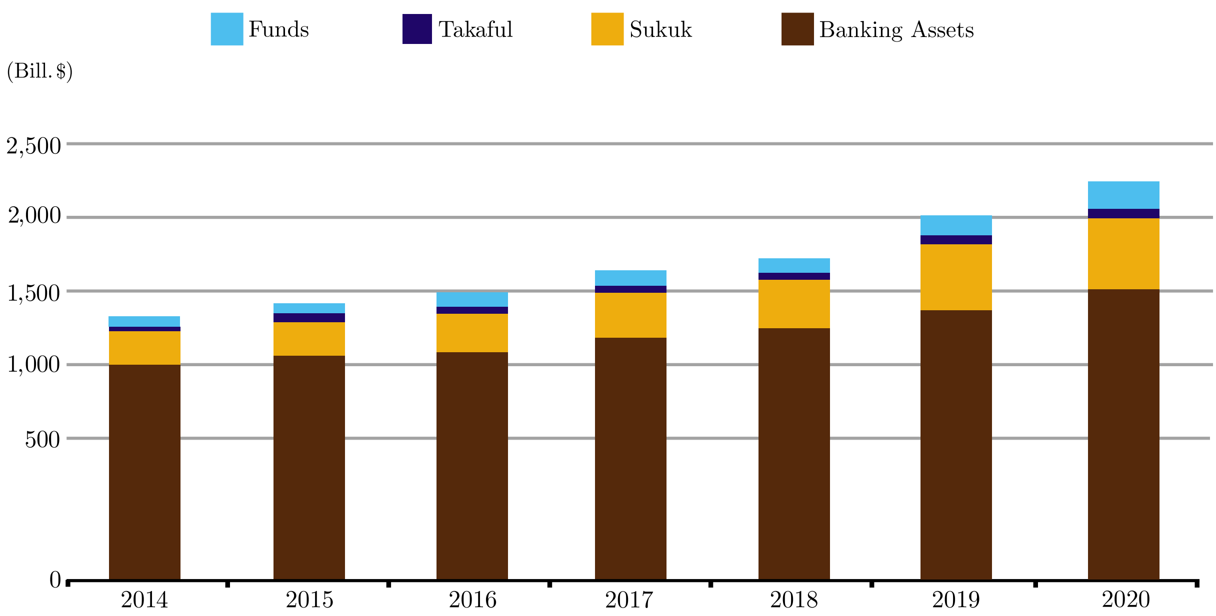
The reaction to the horrific occurrences on the financial markets was that most banks did adjust in their operative business. However, relatively few aspired for a radical change of their industry. Among those who advocated a drastic realignment in economic thinking were the pioneers of Islamic banking. The pioneers had an anchor in the primary teachings of Islam, which mentions quite extensively different principles for believers on how to behave within an economy. These principles have been applied more or less throughout the history of Islamic civilization. The concept of "Islamic banking" itself is a comparatively recent phenomenon.

Warde (2010, p. 73 ff.) describes the emergence of Islamic finance by pointing out that the beginnings were quite humble in the 1970s and 1980s. This "evolution" of modern Islamic finance was influenced by many post-colonial Islamic scholars and can be regarded as a reaction to the western colonization of many Muslim-majority countries. Another aspect raised to explain the rise of Islamic banking is the oil boom, especially in the middle east, which granted these countries petrodollars. Profiteers of the oil boom, institutional and individual investors, wondered how they could invest some of their money in an Islam-

[1] The Financial Instability Hypothesis (Minsky (1992)) describes the current financial system as a primarily interest-based and debt-driven system. In which the goal of reaching full employment is nearly impossible. Minsky believed that a system dominated by interest-based debt contracts is unstable. Minsky further elucidates that an arrangement requiring borrowing to repay debt is speculative finance. The hypothesis of Minsky further implies that if periods of prolonged prosperity and positive prospects arise, financial institutions tend to be more risk-seeking in their investment decisions, which increases the sensitivity of the market towards a situation where default materializes.

compliant way. This was an important driver of the development of many products and instruments, which constitute today's Islamic banking industry.

As mentioned before, after the global financial crisis, Islamic banking experienced an acceleration in its development. According to the IMF (2017), the Islamic banking product variety meanwhile comprises of banking, leasing, securities (*sukuk*), equity markets, investment funds, insurance (*takaful*), and microfinance. The past decade brought the industry double-digit asset growth rates (in terms of assets, the industry grew from 200 billion in 2003 to 1.6 trillion at the end of 2013). According to Standard & Poor's (2022) Islamic banking report, the outlook for asset growth is quite strong despite the pandemic. Due to expected stronger *sukuk* issuance by S&P Islamic finance assets will boost by 10%-12% in 2022. The outlook further finds fault with unutilized potentials, pointing in particular to the lack of standardization efforts and inadequate positioning as a sustainable financing method in an increasingly "greenified" industry. With regard to the potential of Islamic finance in specific countries, Saudi Arabia (Vision 2030 Project), Qatar (FIFA World Cup), and Dubai (Expo) are particularly noteworthy, as they are undergoing infrastructural transformations. There is scope for some further growth through unleashing the opportunities related to the energy transition for some major Islamic finance countries and wider social challenges. Although the pace of growth is upbeat and the outlook is



Source: Central Banks, IFSB, Eikon, S&P Global Ratings.

Figure 1: Global Islamic finance industry assets (2014-2020)

promising, Islamic banking is far from dominating the markets in Muslim-majority countries. According to government information from Iran, Sudan, Brunei, and Saudi Arabia, the markets in these countries are considered largely "Islamized" (IFSB (2017)), which is definitely something to question.[2] The IMF highlights further challenges that exist for the Islamic banking market. First is the regional concentration and confinement of Islamic banking success mainly to the Gulf States, Iran, and Malaysia. Second, compared to global financial assets, the size of Islamic banking makes up less than one percent of total global financial assets.

Nevertheless, it is of extraordinary importance to deal with Islamic banking, because many Muslim-dominated countries are striving for their "own" identity. Many decades after the collapse of the Ottoman Empire, the British Empire or the French Colonial Power from which most Muslim-majority countries emerged, these countries even until today are unable to define, project and sustain a national identity. For many inhabitants of Muslim-dominated countries, this self-defined identity includes a self chosen economic order. While there are also secular social aspirations, still the religious aspiration is of central importance to this monograph and will be analyzed extensively in the sequel.

1.1 Literature Review

There have been many attempts to model and highlight the main differences between Islamic and conventional banking. However, most have shown qualitative differences, and others have focused on banking-related aspects (see, i.e. Beck et al. (2013)). It must be noted that no fully-fledged Islamic economic system is implemented in any Muslim-majority country. Although some countries (i.e. Iran and Saudi Arabia), as mentioned earlier, claim to have fully Islamic financial systems, the reality on the ground is quite complex. As the IMF figures show, the Islamic banking industry is a niche in relation to the international financial market. Mostly it is assumed that Muslim-majority countries' financial systems are running according to Islamic banking principles, but according to Asutay and Turkistani (2015), not even the financial legislation is structured in a way that Islamic commercial banks could smoothly perform (particularly, countries such as Saudi Arabia, UAE, and Qatar). Beyond the legal hurdles, the central banks in Muslim-majority countries are also not designed in favor of Islamic commercial banks, which requires a special regulation according to the peculiarities of Islamic commercial banks (e.g., the affinity to partnership agreements and the zero interest rate rule). Empirical studies are not suitable to study, since nowadays, all countries with a Muslim-majority population operate predominantly according to conventional banking systems. That is why it is essential to draw attention to the theory of Islamic banking system.

The relevant literature for the study comprises modeling approaches that try to sketch a potential/theoretical Islamic monetary system. After carefully observing the relevant and most cited literature in this field, some striking features must be illustrated before diving deeper into the Islamic macroeconomic ideas and models. The macroeconomic literature,

[2] The discussion on how Islamic the named countries are (in financial terms) "really" was well summarized by Khan (2010).

especially related to monetary policy, seems to constitute a relatively small spectrum within Islamic banking literature. The literature published in Arabic and Urdu (Islahi (2014, p. 3)) presents some linguistic hurdles for Western readers, but increasingly there are papers and books available in English. Many of the publications are of poor academic quality. They are self-published or appear in journals with a pretty low rating or, at best, published in working paper series of reputable institutions (such as the International Monetary Fund). Only a few papers have made it into established western economic journals. Another unusual aspect from a scientific point of view is the religious influence on certain publications. The influence manifests itself by Islamic scholars who unusually formalize their economic ideas (apparently without formal finance or economics training). The use of religious prayers at the beginning of books or articles and the open glorification of Islamic history and values is quite common. These facts provide the basis for legitimate doubts on the orientation of those scientists to values such as academic freedom (Kinzelbach et al. (2021)) and the herewith connected impartiality of science concerning religion and politics. Nevertheless, this realization should not hinder the reader from evaluating the existing literature and analyzing every idea that is put forward in this field. The Islamic banking literature can be described by its comparatively small scope, the evolution of ideas, and easily understandable models. The literature on monetary policy can superficially be classified into two categories: qualitative and quantitative. All those works are categorized as qualitative, containing rough ideas of an Islamic monetary system, which in some cases describe more minor relationships by employing equations. Works in this monograph are categorized as quantitative if they at least outline a model-theoretical approach based on mathematical methods.

1.1.1 Qualitative Literature

As it is trackable within the domain of English economic Islamic banking papers, in the early 1980s, ideas started to emerge that a potential sizable Islamic banking sector (within an Islamic economy) would require a supportive central banking system. One of the earliest proposals was put forward by Chapra (1983), who stresses the importance of price stability and fiscal soundness in such an environment. Approximately a decade later, Khan and Mirakhor (1994) proposed that an Islamic monetary system should heavily rely on profit and loss sharing contracts to restrain from debt-based contracts and abolish (favorable) interest rates. They further ascertained that an Islamic central bank could utilize nearly all conventional instruments, except those directly connected to interest rates (open market operations and discount rate adjustment). Choudhry and Mirakhor (1997) continued the thoughts on fiscal soundness and proposed that an Islamic government should issue equity-based bonds, and their return should be proportional to the budget balance. Sundararajan et al. (1998) focused on the monetary instruments and tried to introduce innovations in Islamic banking from Sudan and Iran. The instruments comprise interbank market operations and credit facilities.

The announcement to suspend the Bretton Woods System temporarily in 1971 (by US President Richard Nixon) and its unwinding until 1981 (IMF 2022) seem to have had a profound impact on Islamic macroeconomists. The question of how a potential Islamic monetary management should work according to a potential gold backed currency evolved. Chapra (1996) took this question on and tried to find precedences from early Islamic history and concluded that setting up currencies in both ways were possible: fiat or hard money. Koehler (2010) goes way deeper into the historical dimension of hard money in the form of the classical gold standard from the Muslim Empire of the 7th century. In 2010 there was a pivotal moment for the supporters of hard money within the sphere of Islamic economics. In a Malaysian state named Kelantan, a gold Dinar and a silver Dirham were introduced into the market. The effect of this currency was analyzed by Lee (2011). Askari and Krichene (2014) published a book on this topic, where you can find an in-depth contribution to the discussion. Another interesting branch of the discussion on a potential system of monetary management can be found in the wake of the emergence of cryptocurrencies. Bergstra (2015) elaborates on the use case and potential redesign of Bitcoins in the sense of Islamic financial instruments and products. Oziev and Yandiev (2018) and Muedini (2018) analyze the legal compatibility between cryptocurrencies and Islamic law. The authors believe that cryptocurrencies are permissible but with strict reservations.

The development of ideas around an Islamic monetary system is characterized by recurring periods with no noteworthy contributions to the literature. So that Hasan (2008) sees his paper as an attempt to reanimate the whole topic. After providing a glimpse of the status quo, he also criticizes the ignorance and neglect of studying a potential Islamic monetary system. Hasan concludes that Islamic banks can create credits in a conventional way, but central banks should design tools for credit control that correspond to Islamic banks. Hanif and Shaikh (2010) see the importance of presenting an alternative benchmark than the interest rate for Islamic financial institutions. They suggest nominal income growth to be more in line with Islamic law. Tahir (2013) finds that Islamic economics has thought about fiscal and monetary policy island-like, tried to establish a relatively holistic approach, and wrote a piece on coordinating fiscal and monetary policy properly in an Islamic economy. To restart the research on Islamic banking systems, Uddin (2016) gave a review of existing ideas and tried to inspire further research.

Understanding the interplay between verbal ideas and economic modeling required looking at the qualitative literature. In the upcoming subsection, attention is paid to quantitative economic models.

1.1.2 Quantitative Literature

The evolution of macroeconomic Islamic banking models starts with Classical Keynesian IS-LM Models. One of the first attempts to formalize such a model was undertaken by Al-Jarhi (1980), who had highly rudimentary ideas on modeling Islamic monetary policy. Among his ideas were a restructuring of assets and liabilities (of a potential Islamic central bank) in a way that interest is not involved, set reserve requirements of Islamic commercial banks to one hundred percent, and introduce the system of Islamic wealth taxation (*zakat*). Mirakhor et al. (1988) modeled an open Islamic economy in the Tobin and Brainard (1967) form. The aim was to develop it as understandable as possible, wherein the domestic private sector can choose to allocate its wealth between bank deposits, bank equities, and physical capital. The bank deposits do not pay interest; instead, they pay them a profit share, which can turn negative in case of losses. The central bank lending for Islamic commercial banks was very limited in the model. Khan and Mirakhor (1989) have also used the Tobin-Brainard approach in a closed economy focusing on monetary policy. They conclude that an Islamic IS-LM Model has similar outcomes in terms of monetary policy effects as the conventional IS-LM model. Mirakhor (1993) takes the open economy approach and shows that a fixed exchange rate favors an Islamic economy if it chooses to open up to international trade. Zangeneh (1995) confronted the perception that an economy without interest rates would experience massive capital flight in any case. He finds that the fall in investments would highly depend on profit and participation rate connected to the Islamic investments of partnership-based contracts (*musharakah*) and trust financing (*mudarabah*). Darrat and Bashir (2000) took a portfolio variant of the IS-LM Model to work with more than one sector (banking). They concentrated their monetary policy analysis on changes in reserve and profit-sharing ratios as monetary instruments. They additionally included the Islamic wealth tax (*zakat*) in their money demand. Kiaee (2007) compared interest-based and non-interest-based monetary policy instruments and concluded that interest-based instruments showed more stable and flexible results regarding the money and goods market.

Then approximately in the mid-2000s, a new set of equilibrium models occurred in the spirit of the New Keynesian approach. Feizi (2008) modeled a small open economy. He considers interest rates because, according to him, some hidden forms of interest rates are influential in Muslim-majority countries such as Iran (e.g., housing sector). In his view, the exchange rate can play a crucial role in smoothing inflation and output in such an economy. Soleimani et al. (2014) looked at a closed economy. They created a government joint venture (*musharakah*) monetary policy rule to replace the classical interest Taylor Rule, which turned out to be equally responsive to inflation and output gap. Wong and Eng (2018) included a feature called financial acceleration designed by Bernanke et al. (1999) into their model, excluded interest rates, included Islamic contracts, and concluded that the outcomes of their Islamic banking model are difficult to differentiate from a conventional model. Hadian (2017) went for a direct comparison between interest-based models and non-interest-based models. Therefore he introduced two monetary policy rules. The non-interest-based monetary rule involved an expected return on real projects, which was positive in boom phases and negative in recessionary economic phases. He concluded that the non-interest-based model outperformed the interest-based model in the face of shocks (in terms of less volatile outcomes for investment and output). Dahani and Aboulaich (2018) also tried to assess the influence of Islamic commercial banks in a market and replaced the interest rate with a return on capital. They find that Islamic commercial banks contribute to the stability of the overall market.

1.2 Scheme of the Monograph

This monograph attempts to translate the qualitative principles into a standard macroeconomic model. The idea is to model a potential version of a full-fledged Islamic financial system that consists of a central bank, commercial banks, households, and companies. There is relatively thin literature available on the differences between the two systems from a macroeconomic and systematic point of view.

Accordingly, in chapter 2, the basic concept of Islamic banking will be described. That will contain the main principles relevant to the monetary system regarding interest rates, credits, investments, deposits, central banking, and commercial banking.

Chapter 3 will modulate a Keynesian version of the Islamic banking model. Therefore, it is necessary to translate the qualitative principles into an algebraic model. Afterward, a static model will be created to analyze various aspects of the Islamic monetary system in two steps: First, an Islamic money-credit-stock-market model followed by an attempt to confront the model with some standard shocks, and second, an Islamic money-credit-real-capital-market-model will follow to analyze some cross-market repercussions. These two steps are crucial because the Keynesian literature on Islamic banking (cf. subsection 1.1.2) has not considered the effects on credit and stock market specifically. The simple stock market is a proper way to introduce the spirit of profit and loss sharing into a potential Islamic economy in a market-efficient way. The credit market (though less important than in a conventional interest-based system) must be given special attention because not every individual in the market (households or companies) might be able to attain investment capital from the stock market (or respectively from the actual capital market). Based on the assumptions made so far, it is evident that rationing will prevail in the credit market. Another aspect is the wealth tax (*zakat*) that has been introduced in many models but only applied to deposits.The idea needs to be expanded conceptually to the excess reserves (conventional bank's holdings at the central bank). According to the author, this prevents conventional banks from hoarding cash and thereby provides the Islamic central bank with an additional monetary policy instrument. Then in chapter 4, the basic principles are translated into a New Keynesian model. Therefore it is crucial to lay a micro foundation for an Islamic banking version of the New Keynesian model, which is not present in the literature to the best of the author's knowledge. It is vital that a New Keynesian Islamic banking model is not simply an ad-hoc reformulation of conventional New Keynesian models but rather derived from the ground up following the particular specifics of an Islamic banking system. Many New Keynesian models claim to analyze Islamic economies, as shown in subsection 1.1.2, but no model introduces credit market rationing and thus possible imbalances. According to general economic wisdom, it is not possible to set the price of credits (namely interest rate) to zero and to expect the credit market to exhibit an equilibrium. If only one considers this aspect, one has to question results in the literature, which claim that there are no significant differences in outcome between Islamic banking models and conventional models (i.e. cf. Khan and Mirakhor (1989)). The New Keynesian Islamic banking model has to be analyzed in the static form with rational expectations before introducing agents with boundedly rational expectations to the dynamic model extension. To the best of the author's knowledge, the boundedly rational aspect has not yet been applied to Islamic banking models.

2 The Basic Concepts of Islamic Banking

The core principles of the theory of Islamic banking are based on *shariah* law. Hassan et al. (2009, p. 4) describe *shariah* as a code of conduct, which provides guidelines for different aspects of Muslim life. They can be categorized on the one hand in spiritual behavior, the worship of God (*ibadah*) and on the other hand in the behavior of daily life (*muamalat*), such as economics, politics, and business. Warde (2010, p. 32) compares the primary sources on which the commandments are based on as follows: On top, there is *Quran*, the holy book of Muslims, which they consider to be God's revealed words to the prophet Muhammad. Then *hadith* and *sunnah* follow. Both are narratives, small texts gathered by authors after the demise of the Prophet Muhammad.
Then some issues are not addressed directly in the primary sources. As *shariah* is not a codified body of law, in view of the majority of Muslims, the available sources are open for interpretation.
In case of uncertainty according to Kettell (2011, p. 20 ff.) there are other instruments to derive guidance. The first one is the "general agreement" (*ijma*) among Islamic scholars. Due to the vast number of scholars and sects globally, only regional "general agreements" are undertaken. In order to have a brief idea of what Islamic banking is basically about, it is crucial to understand its core principles. After gaining insight into which sources and processes the principles are gained, it is interesting to see which parts of conventional banking are modified by the Islamic understanding of banking. Therefore, the significant banking components will be analyzed in the upcoming subsections, such as money, interest rate, deposits, investment, and central banking.

2.1 Interest Rate

There is relatively little general knowledge on Islamic banking among economists, but what is generally known about it is the perception that Islam is the only world religion prohibits interest rates. As a matter of fact, Islamic scriptures similar to other scriptures of world religions. The primary sources of Islam deal with this subject, better known under the Arabic word of *riba.*
Before starting a proper analysis of *riba* it is noteworthy that the split between conventional and Islamic banking starts with the varying understanding of money. Mannan (1984, p. 33) clarifies that Islam recognizes the role of money solely as a medium of exchange while the role as a commodity is not accepted because money, according to this view by definition, cannot produce anything by itself. The idea that money should not have a store-of-value function is in a way shared by the classic neoclassical theory[3] (in

[3]For a brief overview on classical, neoclassical, and new classical theories and their impact on macroeconomic modeling see Hudea (2015).

sharp contrast to Keynesian theory). As stated in the subsection above - which deals with the sources of Islamic banking - it is difficult to speak of "the Islamic" point of view. So as a consequence, there is a dispute on the correct translation of *riba*. Plainly as "usury" (excessive form of interest rate) or as "interest" in a broader sense? Interested readers can find a brief discussion in Ahmad and Hassan (2007), Mannan (1986), and Saleh (1986). Nevertheless, in standard textbooks, there exists a relatively wide consensus on the understanding of *riba* as "interest". Islamic scholars have put many reasons forward to explain why there is a ban of interest in primary Islamic literature. For a deeper understanding, see Kettel (2011, p. 29 ff.) and Chapra (2006, p. 96 ff.).

However, just limiting the understanding of *riba* on a simple ban of interest does not do justice to this subject. In order to have an in-depth idea of how interest is treated, it has to be considered the institution of the Islamic wealth tax (*zakat*). Because in the conventional understanding of economics and finance, interest is crucial to the system. In theory, the interest rate ensures the pricing of capital and, beyond that, avoids hoarding of cash.

The expression *zakat* means "purification". In Islamic scriptures, a person's wealth is considered as a trusteeship of God. This wealth obliges the wealthy to the religious duty to look after and support the needy. Mannan (1984, p. 52) adds that the actual rate of this wealth tax ranges between 2.5 and 20 percent and plays its role in levying idle money. This is thought to discourage holding cash for speculative motives. These days many Islamic commercial banks have taken the responsibility to collect and redistribute the mandatory levy on behalf of their clients. Warde (2010, p. 145) further elucidates that on behalf of their clients, Islamic commercial banks deploy the collected money in various forms such as for charitable, welfare organizations, outright grants, interest-free loans, or the relief of distressed debtors.

After having an insight into these two vital concepts (*zakat* and *riba*), it has to be understood that in Islamic banking, the positive predetermined rate for loaned capital (interest rate) is replaced by a negative one. Strictly speaking, the interest rate is not abolished in Islamic banking. Its value is simply negative because instead of receiving interest on the saved amount in deposits, the depositor is charged with the wealth tax *zakat*.

2.2 Credits

The prior subsection has shown that positive interest is prohibited in Islamic banking. Now the question arises of how these banks manage debt-based contracts. Apparently, (according to the basic principles) there seems to be a very weak incentive to provide loans.

The interesting concept in this regard is the interest-free loan (*qard hassan*). According to Kettell (2011, p. 33), any payment added to the agreed amount of principal is prohibited. *Qard hassan* is regarded as a "good loan" that is in favor of low-income households. Muslim theologians acknowledge the loss, which arises from interest-free loans to the creditor in the context of inflationary effects, but Siddiqi (2004, p. 133) confronts it by arguing that taking the loss (through inflation and waiver of interest) is part of the charitable giving. Nonetheless, he also accepts that the level of sacrifice by the creditor has boundaries at the latest if inflation climbs into double-digit regions. Lenders would then find it difficult to lend without expecting compensation for inflation.

Another essential instrument to provide for financial means is the so-called cost-plus or credit sale (*murabaha*). In conventional financing, it could be compared with a rent-to-own arrangement. According to Hassan et al. (2009, p. 82 ff.), the client approaches the bank intending to buy a commodity in such credit sales. Then the bank provides the capital and either buys the commodity itself or appoints a third party. The buyer (client) will know the exact purchasing price and the additional profit as part of the agreement. The commodity falls under the bank's ownership or third party until the client has paid off the agreed amount in full.

Beyond credit sale – a widely adopted instrument in Islamic banking practice – there are many other debt-based financing instruments. However, for this thesis, it is sufficient to mention them in the following: manufacture sale (*istisna*), forward sale (*salam*), sale of debt (*bay al-dayn*), securitization (*tawriq*), sale of currency (*sarf*), cash financing (*tawarruq*) and sale with immediate repurchase (*bay al-inah*). Interested readers will find further instruments in Hassan et al. (2009, p. 85 ff.).

2.3 Investment

It has become clear now that no interest is allowed in business transactions and classical credit cannot provide investment capital. The question arises as to how investments are made in the Islamic banking system. After a short description of risk and speculation from an Islamic point of view, concrete instruments are presented to ensure this.
A fundamental principle of Islamic banking is prohibiting excessive forms of uncertainty (*gharar*). Warde (2010, p. 59-60) addresses this by mentioning that the word *gharar* is not mentioned in the holy book of Islam (*Quran*). The term is mentioned in different sayings of the prophet of Islam, so called *hadith*. The word *gharar* is etymologically related to the expressions deception or delusion. In economic context, uncertainty, risk, or hazard is used. The concept of *gharar* is relatively vague because uncertainty in varying degrees is involved in nearly every transaction. That is why *gharar* does not simply stand for risk. It is not about prohibiting risk and not even the advice to avoid risk or become risk-averse. Quite the contrary is the case. Islam permits and encourages risk insistently, just in case of equitably shared risk by the involved transacting parties.
Another principle is *mayseer*, which can be translated as gambling and is prohibited in the *Quran* according to Hassan and Lewis (2007, p. 39-40). The word comprises the whole range of games of chance/hazard. *Mayseer* is derived from the Arabic root of *usr*, implying ease and convenience, which reflects the Islamic perception about gambling. It is viewed as a behavior of earning/enhancement of wealth without undergoing any effort. Besides the ordinary gambling in casinos/gambling halls, all kinds of business contracts induced to gamble are also prohibited.
Debt-based contracts (especially credit sales) are vital in today's Islamic banking concept. Despite this, the highly reputed Islamic scholar Usmani (2002, p. 72) stresses that strictly speaking, credit sales or other debt-based contracts in specific are not the preferred form of finance according to Islamic banking theory. Using these instruments has been allowed by Islamic scholars in order to facilitate a smoother transition towards a proper Islamic economic system. Furthermore, it should be kept in mind that credit sales should only be made in those cases in which equity-based instruments are not practicable. Islamic banking tries to promote long-term contracts based on profit and loss sharing instead of predetermined rates of return (interest rate).

In the following, two equity-based instruments and the conditions under which they are permissible will be presented.

The first instrument is the so-called partnership contract (*musharakah*). Usmani (2002, p. 17 ff.) asserts that this partnership is between the Islamic commercial bank and its clients (i.e., companies). In this joint partnership resulting profits and losses

are distributed according to contractual shares laid down by the parties. In most cases, the shares' proportion to the capital brought into the partnership by both parties, but variation is allowed.
The second instrument is the so-called trust financing (*mudarabah*). If directly compared to the partnership contract, it becomes evident that the distinction between capital and labor/management in trust financing is stricter. Hassan et al. (2009) make it clear that in a typical contract, there is, on the one hand, the financier (*rab al-mal*), and on the other hand, there is the company (*mudarib*). For a detailed listing of the main differences between partnership contracts and (*musharakah*) trust financing (*mudarabah*), see Usmani (2002, p. 31-32). Now the main condition will follow that makes equity-based contracts permissible. Similar to other moral codes, Islam does not allow for all kinds of transactions. The invested business must follow religiously permitted purposes (*halal*). Hassan et al. (2009) specify that this excludes all kinds of unethical industries from an Islamic point of view, such as gambling, alcohol, pork, and pornography. These restrictions make investment decisions relatively complicated for Muslim investors. Therefore the Islamic banking industry has already come up with a "Dow Jones Islamic Market Index", which serves as a heuristic for Muslim investors (Standard & Poor's (2021)). The index only lists those companies in line (with those mentioned above) Islamic investment principles.

2.4 Deposits

As in the conventional banking system, Islamic commercial banks also attract capital, but the deposits they offer for their clients are slightly different. Generally, the deposits can be classified into current, saving, and investment accounts (Hassan et al. (2009, p. 80)). Current accounts (also referred to as *wadi'ah* accounts) manage an individual's/company's cash, checks and bills. The account does not evolve any risk or return. The depositor is only eligible to receive the paid-in amount of the deposit. The contract is solely devoted to the safekeeping of the money on the part of the bank. The Islamic bank can only use the money for short-term liquidity, not long-term investments.
Instead, the bank's capital arising from saving accounts is invested more flexibly. They can do safekeeping (*wadi'ah*), partnership contract (*musharakah*), or trust financing (*mudarabah*). Nevertheless, similar to current accounts, the banks are not required to pay any return. In practice, some Islamic commercial banks pay a gift/premium (*hibah*) to their depositors. In contrast to the conventional banking system, the difference remains that this premium should depend on the bank's investment performance and is hence not predetermined.
The investment account is exceptionally fundamental for the Islamic banking theory because, in this setup, the bank and its clients build a partnership. The terms are mainly

based on trust financing (*mudarabah*), whereby the bank is the active partner (with absolute freedom in management and investment decisions) and the client is the so-called sleeping partner. Subsequently, the client has to be ready to bear profits and losses.

2.5 Islamic Central Bank

Another big misconception about Islamic banking is that this financial system is predominant in Muslim-majority countries. The reality is that Islamic banking is on the rise but still relatively small, even in countries with a majority Muslim population. Consequently, central banks in these countries are set up conventionally. Dar and Azmi (2015, p. 63) point out that all countries that practice Islamic banking lack governance and regulation regimes towards Islamic commercial banks. Those who have started initiatives such as Malaysia have built "shariah advisory councils" in central banks. Hence, all the propositions for an "Islamic central bank" that will follow are not more than proposals. Nonetheless, it is interesting for the proceeding theoretical analysis. In order to form a conclusive "idealized" Islamic banking model, the central bank will also be assumed to be Islamic (details follow in the upcoming chapters).
The main challenge is to replace mechanisms of conventional monetary management that contain interest rates. Especially pricing capital becomes problematic because, in standard theory, that role is performed by the interest rate which is interpreted as the cost of capital (Hayes (2022)). Many ideas to price capital have been proposed, such as taking the refinance ratio (Siddiqui (1982)) or the interest-free loan ratio (Khan (1982)). However, in this monograph, the proposal by Khan and Mirakhor (1989, p. 48) will be implemented, which goes for a hypothetical Islamic central bank that holds equity shares of Islamic commercial banks. So if Islamic commercial banks require liquidity, they can acquire it in exchange for their own shares. Furthermore, these shares are traded in the market, leading to a profit and loss sharing between the issuer (Islamic bank) and the investor (Islamic central bank). This will be handled similar to a trust financing contract (*mudarabah*) as explained above.

2.6 Differences to Conventional Banking

In Table 1, the most critical differences between the Islamic and conventional banking system at the level of principles that govern the two systems are listed.
In conventional banking, money is assigned a store-of-value function in addition to its function as a medium of exchange. The store-of-value function makes money a commodity that is lent between persons in exchange for money (interest). From an Islamic perspective on the contrary, it is emphasized that money cannot create any value on its own, so interest may not be charged by the creditor or paid by the bank on account balances. Instead, from the Islamic point of view, it is expected that a person who avoids market risk should rather

Table 1: Principle-based differences between Islamic and conventional banking

	Islamic Banking	**Conventional Banking**
Function of Money	money should only be regarded as a medium of exchange	money is regarded as a medium of exchange and as a tradable commodity (store of value)
Credits	interest on credits set to zero	interest on credits set by market powers and/or central bank
Investments	moral (*halal*, *gharar* and *mayseer*) and legislative boundaries	only legislative boundaries
Favored Contract	partnership-based-contracts	debt-based-contracts
Deposit	differentiation between safekeeping and finance account	no differentiation
Redistribution	*zakat* as a tax on idle capital (shifting means from high-income to low-income individuals)	no such element within the financial system in classical model theory

be taxed through the Islamic wealth tax *zakat*. The revenue from the wealth tax may only be used for charitable purposes and should ideally help to reduce income inequality. According to Islamic banking, loans may only be granted without interest. Since interest as the most important incentive for lending in conventional banking is eliminated in the Islamic system, partnership-based transactions of various kinds become essential. When granting investment capital, it must be ensured that the companies invested in are engaged in business that is permissible from an Islamic point of view (*halal*), do not take excessive risks (*gharar*) and have a gambling character (*mayseer*).

3 A Keynesian Islamic Banking Model

The modeling of an Islamic banking system is challenging, mainly for two reasons. First, there is no fully functioning comprehensive Islamic banking market in any country that could serve as an example for the modeling. Second, most of the Islamic provisions for an economic system are qualitative. The translation of the primarily qualitative principles into a standard macroeconomic model is aimed to form a purely theoretical (not existing) Islamic banking system. At this point, it is considered essential to emphasize once again that this model formulated in the following constitutes a "thought experiment" on how a model would function if the Islamic principles were applied as "accurate as possible". Especially in the sense that the whole system runs without positive interest, and transactions involving elements similar to interest are not allowed. That has to be achieved by building a model that is heavily based on partnership-based contracts. A framework – that figures out the main differences between the systems – requires sharp lines. Hence, this model will put aside the excessive use of debt-based contracts in today's Islamic banking practice (Khan 2010, p. 806) and the lack of a partnership-based central bank in Muslim-dominated countries. Abbas Mirakhor is one of the few economists who published extensively on this subject. The joint publication by Khan and Mirakhor (1989) will serve as an additional point of reference.

This chapter aims to analyze monetary policy in a modified version of the standard money and credit model that is well known from standard textbooks and is mainly based on the approach of Tobin (1969), Brunner and Meltzer (1972), Stiglitz and Weiss (1981), and Bernanke and Blinder (1988). Jarchow (2010) and Duwendag et al. (2014) have developed these ideas, which will be taken as further points of reference. Modifying the standard money and credit model aims at showing the main differences between the conventional and Islamic banking systems in a Keynesian model world. The analysis starts with a three-markets model and afterward expands to a four-markets model, in which the effects of the real economy will be introduced. Further, the model will be shocked to see the challenges of a full-fledged Islamic banking system.

3.1 Model Description

The analysis begins with a drawing up of the balance sheets of all concerned institutions. As it is observable in Table 2, there are balance sheets for the Islamic central bank, Islamic commercial bank, and non-banks. In order to derive the model equations, the consolidated balance sheet is helpful. The consolidated balance sheet consists of the balance sheets of Islamic banks and non-banks. The notation of the balance sheets is defined as follows: S

Table 2: Balance sheets of the Islamic banking system

Islamic Central Bank		Islamic Bank		Non-Bank	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
A_{ICB}	ER	A_{IB}	D_{SAV}	D_{SAV}	A_{ICB}
B_{GOV}		ER	D_{INV}	D_{INV}	A_{IB}
T_{ER}		K	S		B_{GOV}
S		T_{SAV}	T_{ER}		T_{SAV}
					K

Consolidated	
Assets	Liabilities
A_{ICB}	D_{SAV}
A_{IB}	D_{INV}
B_{GOV}	
T_{SAV}	
K	

= the amount of credit that the ICB lends to the Islamic commercial bank, ER = excess reserves, A_{ICB} = amount of stocks possessed by the Islamic central bank, A_{IB} = amount of stocks possessed by Islamic commercial banks K = credits to the non-banking sector, D_{SAV} = savings account, D_{INV} = investment account, T_{ER} = tax amount on excess reserves paid by Islamic commercial banks, T_{SAV} = tax amount paid on savings accounts by non-banks, B_{GOV} = government Islamic bonds held by the Islamic central bank, B = Islamic bonds (*sukuk*).

In the following, it is helpful to consider figure 2, where a simple circulation model presents the basic structure of the Islamic banking system. The main agents of the system are non-banks (NBs), Islamic commercial banks (IBs), and the Islamic central bank (ICB). NBs itself comprise of households (HHs), companies (COs), and the government (GOV). This model abstains from foreign countries (closed economy assumption). The arrows in the circulation model are according to the respective cash flows in the system. The arrows can be interpreted as follows: NBs ($\cdots >$), IBs ($- - - >$), and ICB ($- \cdot - >$).

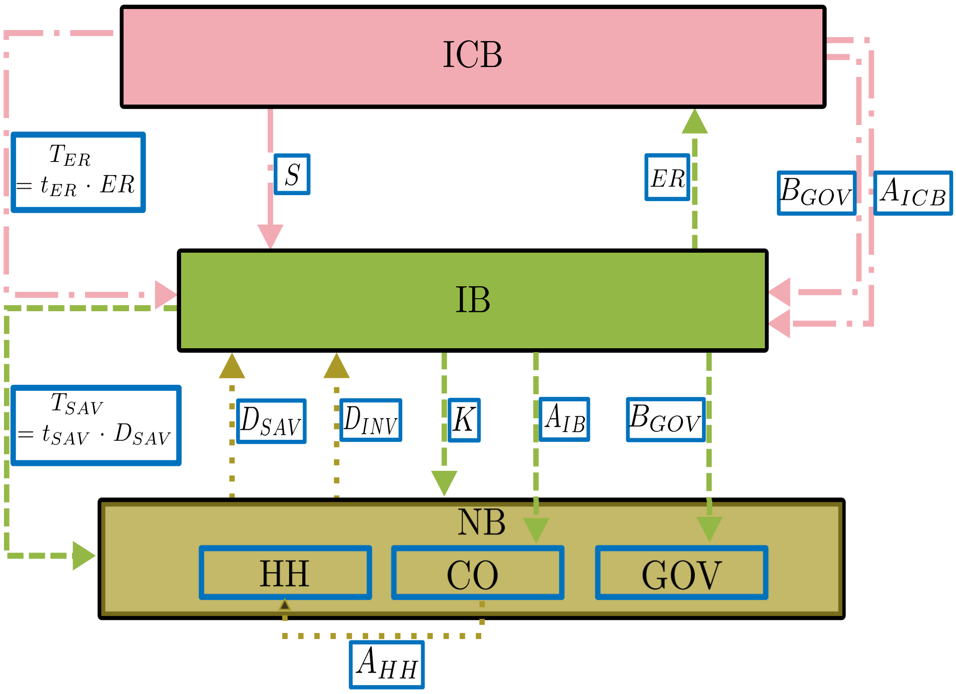


Figure 2: Basic structure of the Islamic banking system

3.1.1 Non-Banking Sector

The non-banking sector consists of households (HHs), companies (COs), and a government (GOV). They can choose between a savings account D_{SAV}, which is riskless, and an investment account D_{INV}, in which the NB shares the risk with the IB.[4] In distinction from the classical conventional model, an investment account D_{INV} is added, and cash C^{NB} is excluded from the system (abolishment of cash was a prominent proposal in the aftermath of the financial crisis of 2007/2008 in order to facilitate negative interest rates (Rogoff (2014))). The introduction of D_{INV} has far-reaching consequences for the monetary side of the model because D_{INV} is not per se defined as a cash-like deposit as in the case of D_{SAV}. D_{INV} can be instead interpreted as a fixed-term deposit. The difference to commonly known time deposits is that (consequently) there is no interest rate income. The non-banks have a decision rule to set a ratio between the two deposits, which is:

$$D_{INV} = \alpha \left(\overset{(+)}{e}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho} \right) D_{SAV} \tag{1}$$

where e = stock market return, t_{SAV} = tax levied on savings accounts and ρ = general risk parameter of the market.[5] As a moderately risk-averse non-bank, the decision will not be an either-or decision between the two deposits. This counts for high-income households

[4] In the Islamic finance literature the differentiation instead is made between current account (*wadi'ah*) and savings account as it is practiced in Islamic banking (compare with subchapter 2.4).

[5] The risk parameter implicitly stands for the credit (ρ_K) and stock market (ρ_A). For simplicity, the author assumes that $\rho_A = \rho_K$.

and high-income companies. Those among non-banks who suffer financial constraints (such as low-income households and low-income companies) are assumed to be recipients of transfer payments or good loans from the tax revenue T_{SAV}. Additionally, they are assumed to hold D_{SAV} temporarily for transaction motives only because they are supposed to spend all their transfer payments for basic needs.

The investment account coefficient $\alpha \geq 0$, which can be interpreted as the share of D_{INV} in comparison to D_{SAV} (α is similar to the cash ratio c^{NB}) from the conventional system). The coefficient itself depends positively on the return on stocks $\alpha_e > 0$ because a rising return on stocks is assumed to make investment accounts more favorable relative to savings accounts. $\alpha(\cdot)$ is assumed to be positively dependent on the tax on savings accounts ($\alpha_{t_{SAV}} > 0$) because the agents will shift over to D_{INV} in order to avoid the tax hike (more details on t_{SAV} in subchapter 3.1.2).

The coefficient is assumed to be negatively dependent on the joint risk parameter of the credit and stock market ($\alpha_\rho < 0$) because a higher risk parameter would make riskless savings accounts relatively favorable compared to investment accounts.

The respective deposits are on the asset side of the non-banks' balance sheet (cf. Table 2). In contrast to the conventional banking system, the savings account in the Islamic banking system is assumed to earn no positive interest and is even taxed (for more details, see the following subchapter 3.1.2).

Additionally, the model enables households to possess shares of the companies directly (A_{HH}). A_{HH} has to be differentiated from the shares held by the Islamic commercial banks (A_{IB} will be introduced later on). A_{HH} instead can be interpreted as an employee participation, which is quite common in many larger companies. A_{HH} is only observable in the circulation model (cf. figure 2), not in the balance sheets of the system (Table 2), because in accounting terms, it is a process within the non-banking sector. Hence, A_{HH} does cancel out. The absence of A_{HH} in the balance sheet is in line with the traditional money-credit-asset-market-model.

Shares from the stock market A can principally be emitted by the high-income COs. Low-income COs are assumed to rely on credits K mainly. It does not mean that high-income COs are independent of credits. It means that high-income COs can decide between emitting stocks or borrowing to refinance their investments. The implications of this assumption will be shown as shocks are analyzed.

The ICB, as part of their intervention policies, buys stocks from the COs. In this purchase (considering Table 2), the stocks emitted by the companies held by the ICB are on the liabilities side of the NB balance sheet. The offsetting entry in the ICB balance sheet is on the assets side.

The GOV (government) can emit Islamic bonds B_{GOV} in order to finance major projects (the emitting process is shown in Table 2 by putting B_{GOV} in the NB balance sheet on the liabilities side). These bonds are assumed to be bought entirely by the ICB (indicated in Table 2 by putting B_{GOV} in the ICB balance sheet on the asset side). The GOV reallocates the financial means generated by this action among the NB sector. The IB only serves as an intermediary between the ICB and NB. The exchange with the ICB ends up with a higher ER holding. The IB does not hold B_{GOV} rather A_{IB}, which has the potential to generate a positive rate of return e. So the spending of the GOV in the form of government yields G is not included in the NB balance sheet. The return and the risk of these bonds are assumed to be zero ($i_{B_{GOV}} = \rho_{B_{GOV}} = 0$)[6].

3.1.2 Islamic Commercial Bank

The Islamic commercial banks collect the funds (D_{SAV} and D_{INV} on the liability side of the IB balance sheet). In order to encourage investments the savings accounts are taxed ($0 < t_{SAV} < 1$) by the IB[7] through a wealth tax (*zakat*), which amounts to 2.5% ($(1 - t_{SAV})D_{SAV}$). The amount of the tax (in the interval between 0 and 1) is assumed to be variable. A saving deposit (as mentioned before) with no predetermined interest rate and a levied tax leads to a negative interest rate in the system. The sum of the tax income ($T_{SAV} = t_{SAV}D_{SAV}$) is reallocated as transfer payments or "good loans" (*qard hassan*) to low-income HH and CO (asset side of the IB balance sheet). In order to guarantee that non-private institutions regulate the system, the tax rate is assumptively set by the Islamic central bank. The collected funds (D_{SAV} and D_{INV}) can be invested by the IBs in three ways:

First, profit and loss sharing instruments (such as partnership contracts/trust financing/venture capital) are represented by the stock market[8] shares A_{IB}. The shares possessed by IBs are located on the asset side of the IB's balance sheet. The return of the amount of stocks is defined as a dividend yield ($e = \frac{\text{dividends per share}}{\text{stock price}} = \frac{Div}{P_A}$). The dividends Div represent the distribution of total profits (assumed to be exogenous and constant[9]) on the total number of shares. The stock price P_A is expected to be flexible and inversely related to e.

Second, the Islamic commercial banks can build excess reserves (ER) at the Is-

[6] Expediently, according to the Neokeynesian theory (as laid out in Felderer and Homburg, 2005) the government bond is expected to be interest-free and risk-free. So that private agents in the system have no incentive to buy B_{GOV}. The only demand for the government bonds comes consequently from the ICB.

[7] The tax t_{SAV} is determined by the ICB and collected by the IBs.

[8] The stock market has served as a representative market for all kinds of profit and loss contracts in the system. Consequently, the raising of capital on the stock market is only confined to high-income companies.

[9] There might be some resemblance to consols, which are government securities without redemption date and with a fixed annual interest rate, that is not intended. The constant and exogenous character of the dividends in the model is an assumption-based simplification. Possibilities to enhance the model by endogenous dividends will be shown in Chapter 4.

lamic central bank. The ER is placed on the asset side of the IB's balance sheet. In the same manner, as the wealth tax on commercial banking level (t_{SAV}), the tax on central banking level t_{ER}[10] amounts to 2.5% (assumed to be flexible). Nevertheless, the only difference is that the collected sum T_{ER} is reallocated to Islamic commercial banks, which are financially distressed (low-income banks) and in need of a "good loan". The reallocation is not modeled explicitly but indicated in the Islamic commercial bank's balance sheet by T_{ER}.
After realizing that a typical Islamic commercial bank has to relinquish the return on credit, the bank becomes practically an intermediary between the respective agents in the model (Islamic central bank and non-banks). This insight also shows the necessity of good loans in the case of Islamic commercial banks.
In order to ensure that the bank undertakes all three investment options (money, credit, and stocks), the investment behavior of the bank will follow a portfolio approach. The bank will act as a moderately risk-averse intermediary.

Third, in debt-based contracts (K) such as interest-free loans or credit sales, which are demanded by all non-banks (NBs). In the IB balance sheet, the credits are on the asset side. It should be noted that all kinds of credits (K and T_{SAV}) are given at zero interest. But in case of T_{SAV} they are provided as a "good loan" (*qard hassan*) to low-income HH (T_{SAV}). The modalities of repayment for a "good loan" are far more relaxed. If the repayment process is interrupted by problems (on the borrower's side), the lender is compelled to facilitate the delay or cancel the debt situationally. In this model, the profits obtained by credit sales and interest rate for loans are assumed to be zero to be in line with the prohibition of the positive interest rate. Contrary to this assumption in the Islamic banking practice, some mechanisms mimic the conventional ways of debt finance with positive predetermined returns. These mechanics are justified as necessary measures in a transitory phase towards a full-fledged Islamic banking system (Khan 2010, p. 806) with no positive interest rates. Hence, for this model assumptively, there exist neither profits nor transaction costs in the market. Consequently, the returns to debt-based contracts are fixed to zero. Fixing the interest rate to zero has vast consequences for the credit market. Suppose the interest rate is, on the one hand, the pricing mechanism for optimal credit allocation and, on the other hand, a means for banks to maximize their expected rate of return (as suggested by Stiglitz and Weiss (1981, p. 394)). In that case, a fixed interest rate leads to rationing outcomes. The idea of Stiglitz and Weiss (1981) is that there exists a single profit-maximizing interest rate. Any (downward or upward) change in this specific interest rate would lead to adverse selection and Moral Hazard

[10] This tax solves two problems at once: First, it affects the ER as a negative (penalty) interest rate (zero interest rate plus wealth tax), and second, it raises funds to provide credit to banks with acute liquidity shortage.

effects on the credit market. According to this statement, the interest rate in the Islamic banking model (fixed to zero) naturally entails a high demand for credits. In principle, the outcome of the credit market should be a disequilibrium.
The reader might be irritated by this persistent disequilibrium outcome that is not balanced by another market outcome or one price, as Walras's Law suggests. According to Clower (Walker (1986, p. 48-56)), the general equilibrium theory is just an exceptional case in Keynesian theory and not the rule. Hence, Clower (Walker (1986, p. 51)) formalized a dual decision hypothesis, which analyzes the spillover effects of a disequilibrium from one market to another. Thereby, the rationing barriers of one market are taken into account in the effective decisions of another market so that they are dependent on relative prices and Keynesian elements (such as transaction elements).

3.1.3 Islamic Central Bank

Again, this modeled ICB has no existing central bank (in the Muslim-majority countries) that could serve as a role model. All features in the following are modeled consistent with a partnership-based Islamic banking model.
The money aggregate M in this model is reduced to deposits (in both deposits (D_{SAV} and D_{INV}), the interest rate is zero):

$$M = D_{SAV} + D_{INV} \Leftrightarrow \tag{2}$$

$$M = (1 + \alpha(\cdot))D_{SAV} \tag{3}$$

Through the addition of the D_{INV}, as explained above, time deposits are introduced to the system. They have an impact on the money aggregate because, in contrast to the conventional banking system (where the money aggregate comprises cash C^{NB} and D_{SAV}), the money aggregate contains not only cash-like positions. Hence, the money aggregate defined for this model is an extended money aggregate ($M^+ = M$). The extension of the money aggregate through time deposits is also in line with Islamic banking principles because they prefer long-term investments (see subchapter 2.3).
Furthermore, there is no cash and minimum reserve in contrast to conventional models. Cash holdings C^{NB} are assumed to be zero ($C^{NB} = 0$) in order to avoid hoarding cash in the face of the prevailing negative interest rate. If the Islamic commercial banks require liquidity, it is possible to use the tender procedure offered by the ICB. The approach follows mainly the example of the ECB Tender Procedure (ECB (2022)). The only difference is that the loan given to the Islamic commercial bank is free of interest. The loan S for IBs granted by ICB is on the asset side of the ICB balance sheet (Table 2).
Besides the possibility for Islamic commercial banks to attain liquidity through S, it is also possible to get credits from the collected sum of the wealth tax (by the ICB) on excess reserves T_{ER}. The Islamic commercial banks can have recourse to capital out of the

tax revenue T_{ER}, which serves as a "good loan" for commercial banks facing a liquidity shortage. The amount of credit (loan) available is limited to $T_{ER} = t_{ER}ER$.

In this model, the Islamic central bank can also provide liquidity to the NBs, as it is observable in the circulation model (figure 2). The process is indicated in the balance sheet system (Table 2), where the ICB holds shares of companies (A_{ICB}). The process can be understood as a refinancing measure, and a means to undertake monetary policy actions. In every transaction (buying or selling shares), the ICB technically has to include the IB as an intermediary because a direct interaction between ICB and a CO is not possible because there is no cash ($C^{NB} = 0$) in the system. Therefore the whole process has to be divided into two steps. Suppose it is considered that the ICB is buying shares A_{IB} then in the first step, the IBs will have to buy shares from COs in exchange for deposit money (D_{SAV} or D_{INV}) and in the second step sell it to the ICB in exchange for ER. Nevertheless, in the balance sheet system (Table 2) and the basic structure (figure 2), it will be assumed that the ICB would directly buy or sell from/to the CO to keep things simple.

Another way to provide liquidity for the NB is by undertaking a classical open market operation. Thereby the government (GOV) issues bonds B_{GOV} and the central bank purchases the bonds. In the present case, particular kinds of bonds are issued by the government; so-called "Islamic bonds" (*sukuk*).

According to Habib (2018, p. 218), Islamic bonds have two main differences from conventional bonds. First, the Islamic bond is no debt instrument but rather ownership of an underlying asset. Second, the return on the Islamic bond is a profit ratio (proportional to the ownership), and the return on the classical bond is a predetermined interest rate. Hassan et al. (2009, p. 261) elucidate that Islamic bonds are emitted mainly by Muslim-majority countries, i.e., Saudi Arabia, to refinance several public projects.

Similar to the purchase of stocks A by the ICB, there is no direct purchase in the model (Figure 2) but a two-step mechanism (as explained earlier). In the case of the balance sheet system (Table 2), there is a direct purchase of B_{GOV} by the ICB.

3.1.4 Differences to Conventional Keynesian Models

In Table 3 the most critical differences between Islamic and conventional banking systems in the context of Keynesian models are displayed, which govern the two systems. For the conventional banking model, any basic textbook model (comprising money, credit, and bond market) can be taken, but the author highly recommends Jarchow (2010, p. 62-112). The Keynesian Islamic banking approach will work with heterogeneous agents including redistributive elements. The conventional model in its classical version is usually built on homogeneous agents. This does not mean that conventional banking models are not suitable for redistributive elements, but an Islamic banking model instead is not conceivable without redistribution. The requirement to donate to the needy is given through a wealth tax system (*zakat*) and, in the here presented Keynesian Islamic banking model, collected through the tax rates t_{ER} and t_{SAV} by the Islamic central bank and Islamic commercial banks, respectively. In the next step, the tax revenues are redistributed to the low-income households, firms or even banks that face liquidity constraints.

To prevent individuals from hoarding money in the Islamic banking system, cash is abolished, unlike in the conventional model. Individuals can choose between keeping a savings account D_{SAV}, or an investment account D_{INV}. The D_{SAV} protects savers from any risk, but in return they are taxed by t_{SAV}. The D_{INV} on the contrary exempts individuals from the tax, but they share the risk with their banks, which leads to the fact that they are not guaranteed to get back the amount originally deposited in the account. In return, investment account holders can share in any Islamic bank's profit.

The Islamic banking model is based on partnership-based contracts. This is illustrated by the fact that the stock market A and later in the model the market for real capital A^+ with their respective prices: dividend yield e and Tobin's q are given central importance. The whole system has two significant disadvantages compared to the conventional system: First, the risk of maturity mismatch from the point of view of balance sheets is greater in the Islamic system. Second, the market prices e and q cannot, unlike the interest rates, bring all markets into equilibrium according to the law of one price.

It is also important to think about a central banking system that fits the specifics of the Islamic banking system. It is true that the instruments are identical at first glance. However, a closer look reveals that in the case of liquidity provision, the Islamic central bank may never charge a positive interest rate. In the conventional system, it is possible to charge zero or even negative values for the interest rate, but in "normal times", a conventional central bank will charge positive interest rates.

In case of other monetary policy instruments, an Islamic central bank would necessarily have to rely on the purchase of shares in its monetary policy in addition to the classic conventional bond purchase. On the issue of interest rate control instead of being to choose a variable interest rate freely, the Islamic counterpart would have to limit itself to controlling the respective taxes t_{SAV} and t_{ER}, which creates for them a binding "zero upper bound".

Table 3: Model-based differences between Islamic banking and conventional banking in the context of Keynesian models

	Islamic Banking	**Conventional Banking**
Agents	heterogeneous agents (low-income and high-income HHs, COs and Banks)	homogeneous agents without any differentiation
Cash	cash C^{NB} is abolished in order to avoid hording in the system	cash C^{NB} is typically in place
Deposit	• investment account: depositor shares the risk of the bank, the return is uncertain. • savings account: depositor gets the whole deposit back, the return is zero. If savings are not moved over time then wealth tax (*zakat*) is levied.	the depositor in the basic version of the conventional models gets (usually) a positive predetermined interest rate without the possibility to choose between different forms of deposits
Balance Sheet	many positions put into the Islamic bank's balance sheet that are partnership-based, such as investment deposits (risk of maturity mismatch)	conventional bank's balance sheet mainly dependent on debts
Redistribution	*zakat* is formalized as t_{ER} and t_{SAV} and allows shifts of financial means from high-income to low-income Banks/ COs/ HHs.	no such element
Central Bank	• loans: by acquiring shares S of a bank that is in need of liquidity, purchase of stocks A_{ICB}, and purchase of government bonds B_{GOV} • interest rate: the overall interest rate is set to zero and adjustments in the negative range are only possible through the respective taxes (t_{ER} and t_{SAV})	• loans: by providing loans to the bank that is in need of liquidity and purchase of government or corporate bonds B • interest rate: the interest rate management serves as the core of a conventional central banking operation
Market Price	dividend yield e, relative price of real capital (Tobin's) q	interest rate for bonds and credits
Market Clearance	not always given, especially in the credit market → possibility of rationing (because interest rate is set to zero)	in situations with free floating interest rate (usually) a tendency towards equilibrium
Asset Market	stock market A, real capital market A^+ and Islamic bond market B_{GOV}	bond market B

3.2 Model Specification

After getting an insight into the basic principles of Islamic banking and the significant differences to the conventional system, now the focus is on creating a three-markets model. It is essential to take the conventional three-markets model as an example. It is simply not sufficient to just set the interest rate to zero. The aim is to create an approach that takes the specific assumptions of the Islamic banking system into account. The conventional three-markets model usually consists of the money, credit, and bond market. In the Islamic banking version, the bond market is substituted by the stock market. The extensive consequences of these changes will be disclosed in the following.
From the central bank's balance sheet (Table 2), the monetary base B_m is attained by equating the respective positions from the asset side of the ICB balance sheet with positions of the liability side:

$$B_m = A_{ICB} + B_{GOV} + S + T_{ER} = ER \tag{4}$$

The monetary base B_m has to be corrected by the variables that are influenced by the IBs in order to attain the adjusted or exogenous monetary base B_m^x that is directly controlled by the ICB:

$$B_m^x = A_{ICB} + B_{GOV} = ER - T_{ER} - S \tag{5}$$

Hence, both expressions $(A_{ICB} + B_{GOV})$ and $(ER - T_{ER} - S)$[11] represent the corrected monetary base B_m^x. These are vital to indicate the explicit aggregate of money under the central bank's direct control and free from the influence of Islamic commercial banks. The adjusted monetary base B_m^x in a closed economy is independent of currency reserves. The Islamic bank's balance sheet and the consolidated balance sheet (Table 2) are under consideration of the following two equations:

$$T_{SAV} = t_{SAV} D_{SAV} \tag{6}$$

$$T_{ER} = t_{ER} ER \tag{7}$$

and can be rewritten as

$$A_{IB} + ER + K + T_{SAV} = D_{INV} + D_{SAV} + S + T_{ER} \Leftrightarrow \tag{8}$$

$$A_{IB} + K = (1 + \alpha(\cdot) - t_{SAV}) D_{SAV} + S + (t_{ER} - 1) ER \tag{9}$$

[11] After the model will be fully set up, shocks will be carried out, in which this term will become relevant. If now the tax on excess reserves ($dt_{ER} < 0 \rightarrow dT_{ER} < 0$) falls, the reaction would be that the other components of the equation adjust themselves in a way that the necessary condition $dB_m^x = 0$ is fulfilled.

or equivalently, under consideration of (5), as

$$A_{ICB} + A_{IB} + B_{GOV} + K + T_{SAV} = D_{SAV} + D_{INV} \Leftrightarrow \tag{10}$$

$$B_m^x + A_{IB} + K + T_{SAV} = M \tag{11}$$

Equation (9) displays the ability of the IB to demand stocks (A_{IB}) and supply credits (K). Precisely this ability of the IBs ($S + T_{ER} - ER = S + (t_{ER} - 1)ER$) is extended by refinancing mechanisms at the ICB (S and T_{ER}) and limited through the build-up of ER. In (11) the expression ($D_{SAV} + D_{INV}$) has been replaced by M (money aggregate (equation (2)) and the expression ($A_{ICB} + B_{GOV}$) by B_m^x. The B_m^x stands for a money aggregate that the ICB fully controls. Hence, there exist two ways to create additional money for the ICB (see figure 2). First, by purchasing A_{ICB} from the private sector (NBs). Second, by purchasing government bonds B_{GOV}.
The credit supply is expressed as a proportional behavioral function of the Islamic bank's available funds:

$$K^S = a\left(\overset{(-)}{e}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}\right)(1 + \alpha(\cdot) - t_{SAV})D_{SAV} \tag{12}$$

The credit supply coefficient $a(\cdot)$ depends negatively on the stock market return e ($a_e < 0$) because if the stock market return rises, then investing in stocks (as a substitute for money and credit market) becomes relatively more attractive for IBs. The coefficient $a(\cdot)$ has a positive relation with the amount of loans S lent by the ICB to IB ($a_S > 0$), because if $dS > 0$, then the Islamic commercial bank receives credits from the central bank and thus has a greater liquidity leeway to offer more credit supply. The credit supply coefficient reacts positively on the respective wealth taxes t_{SAV} and t_{ER} ($a_{t_{ER}} > 0$ and $a_{t_{SAV}} > 0$). If each of them rises, then it is an incentive to refrain from increasing the amount of ER, and D_{SAV}, so more capital stays available to offer credits (substitution effect). The credit supply coefficient decreases in the view of a rising joint risk parameter ρ of the stock and credit market ($a_\rho < 0$) because a higher risk on the credit market is assumed to lead to a decrease in credit supply (cf. (1) and (2)).
Similarly to the credit supply (12), the demand for stocks (which here refers to the stock demand of Islamic commercial banks ($A^D = A^D_{IB}$)) can be expressed as:

$$A^D = b\left(\overset{(+)}{e}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}\right)(1 + \alpha(\cdot) - t_{SAV})D_{SAV} \tag{13}$$

The stock demand coefficient $b(\cdot)$ depends positively on the stock market return ($b_e > 0$) because an increase in the return of the stock market increases the willingness to demand stocks. The coefficient reacts positively to an increase of the Islamic bank's loan amount received by the ICB ($b_S > 0$) because more liquidity is available for the Islamic commercial bank to demand stocks. The coefficient rises if the respective wealth taxes rise ($b_{t_{ER}} > 0$ and $b_{t_{SAV}} > 0$) because the increase is assumed to reduce the build-up of ER and D_{SAV}, indicating that more funds are likely to be available to buy up stocks. The coefficient falls in the wake of a rising joint risk parameter of the credit and stock market ($b_\rho < 0$) because a higher risk on the stock market is assumed to lead to a decrease in the demand for stocks.

Inserting credit supply (12) and demand for stocks (13) into Islamic bank's balance sheet equation (9) gives:

$$[a(\cdot) + b(\cdot) - 1]\,(1 + \alpha(\cdot) - t_{SAV})D_{SAV} = S - (1 - t_{ER})ER \tag{14}$$

In case the IB needs more liquidity, then the bank has two options to choose from: either they borrow money out of ICB's tender procedure S or borrow money from the collected amount of wealth tax (T_{ER}). If the net balance between the ICB and IB ($S - ER + T_{ER}$) is smaller than zero, then according to (14), the sum of the credit and stock coefficient has to be smaller than one ($[a(\cdot) + b(\cdot) < 1]$).

In order to obtain the money supply function, take the consolidated balance sheet equation (11) and substitute K and A by equations (12) and (13). After some arrangements (for details, see A.1 in the Appendix), one obtains:

$$M^S = \left(\frac{1 + \alpha(\cdot)}{\Big(1 + \alpha(\cdot) - t_{SAV}\Big)\Big(1 - [a(\cdot) + b(\cdot)]\Big)} \right) B_m^x \tag{15}$$

$$M^S = m^S \left(\overset{(+)}{e}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho} \right) B_m^x \tag{16}$$

where $m^S(> 0)$ is the coefficient for money supply. Further, it can be assumed that the stock demand coefficient is more sensitive to changes in the return on stocks e than the credit supply coefficient ($b_e > |a_e|$).[12] This assumption implies that the IB in this system observes the stock market dynamic and sets the money supply accordingly. Hence, the money supply is positively dependent on the stock market rate of return ($m^S_e > 0$). M^S is furthermore positively dependent on the central bank's credits for Islamic commercial banks ($m^S_S > 0$) and the respective wealth taxes ($m^S_{t_{ER}} > 0$[13] and $m^S_{t_{SAV}} > 0$[14]). The money supply is also positively dependent on the share of D_{INV} in comparison to D_{SAV} ($m^S_\alpha > 0$) and negatively dependent on the joint risk parameter of the credit and stock market

[12] The stock market is assumed to be larger than the credit market in an Islamic banking model. Subsection 2.2 elucidates why there is a weak incentive to engage in debt-based transactions as heavily as in conventional banking.

[13] Through $dt_{ER} > 0$ the amount of ER in the hands of IBs is expected to be reduced. More capital is available for the open market. This substitution effect leads to an increased money supply in the system.

[14] As the tax on savings accounts is increased $dt_{SAV} > 0$, the households tend to divert capital away from D_{SAV}. Hence, there will be less tax revenue T_{SAV}, freeing up more capital for the market.

($m^S_\rho < 0$). In order to attain the credit supply as a function of the exogenous monetary base B^x_m employ equation (12), and thus the following equation is obtained (for details, cf. A.2 in the Appendix):

$$K^S = \frac{a(\cdot)}{(1-[a(\cdot)+b(\cdot)])} B^x_m \qquad \Leftrightarrow \tag{17}$$

$$K^S = k^S \left(\overset{(-)}{e}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho} \right) B^x_m \tag{18}$$

where $k^S(> 0)$ is the credit supply coefficient. Since $a_e < 0$ holds, it can be assumed that the credit supply coefficient is negatively dependent on the stock market rate of return (k^S_e<0). The credit supply coefficient is additionally assumed to be positively dependent on central bank's credits for Islamic commercial banks (k^S_S>0) and the respective wealth taxes ($k^S_{t_{ER}}$>0[15] and $k^S_{t_{SAV}}$>0[16]). The credit supply is supposed to react positively on the joint risk parameter of the credit and stock market ($k^S_\rho < 0$).
In order to complete the three markets the $A^D(= A^D_{IB})$ function dependent on the exogenous monetary base B^x_m is required. Considering equation (13) leads to (see appendix A.3):

$$A^D = \frac{b(\cdot)}{(1-[a(\cdot)+b(\cdot)])} B^x_m \qquad \Leftrightarrow \tag{19}$$

$$A^D = f^D \left(\overset{(+)}{e}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho} \right) B^x_m \tag{20}$$

where $f^D(> 0)$ is the stock demand coefficient. The stock demand coefficient is positively dependent on the stock market rate of return (f^D_e>0)[17]. Beyond that, the stock demand is assumed to be positively dependent on credits for IBs given by ICB (f^D_S>0) and the respective wealth taxes ($f^D_{t_{ER}}$>0 and $f^D_{t_{SAV}}$>0). The stock demand coefficient reacts negatively to an increase in the joint risk parameter of the credit and stock market ($f^D_\rho < 0$).
The following behavioral equations constitute as counterparts to the functions A^D, K^S, and M^S:

[15] The credit supply will rise as it is considered that the increase in t_{ER} will lead to a substitution effect. That in turn will mean that a higher taxation of ER will lead to less ER and probably to a higher supply of credits ($dK^S > 0$).

[16] As a result an increase in taxes on savings accounts, non-banks should increasingly turn to D_{INV}, as expected. Then, the tax revenues of T_{SAV} should decrease and thus more capital should be available for the issuance of credits.

[17] Accroding to the assumption already made that b_e>$|a_e|$, since in an Islamic model one can expect the stock market to be larger than the credit market, the relationship f_e is positive.

$$A^S = P_A\overline{A} = f^S\left(\overset{(-)}{e}\right) \tag{21}$$

$$K^D = k^D\left(\overset{(+)}{e}, \overset{(+)}{Y}\right) \tag{22}$$

$$M^D = m^D\left(\overset{(-)}{e}, \overset{(-)}{t_{SAV}}, \overset{(+)}{\rho}, \overset{(+)}{Y}\right) \tag{23}$$

The stock supply function contains an exogenous and constant number of stocks. The only way the supply changes is with the change in stock price P_A. The stock price is part of the dividend yield $e = (\frac{Div}{P_A})$. So an increasing P_A and a decreasing dividend per share (Div) makes the stock supply coefficient fall.

The credit demand function (22) is positively dependent on the stock market rate of return (k^D_e>0)) because if the stock market return rises ($de > 0$), then (from a portfolio perspective) investing in the stock market with borrowed capital will become relatively attractive. Nevertheless, as the credit amount is limited (rationed), there will be little room for that kind of investment. This is underlined by the inelastic shape of the K^D line compared to the K^S. The coefficient is positively dependent on the national income (k^D_Y>0) because the increase in national income leads to a rise in the total transaction volume, which leads to higher credit demand. This reaction aligns with Islamic banking principles because the system generally encourages partnership contracts and discourages debt-based contracts (see subsection 2.3). The credit demand itself is finitely defined even though the interest is set to zero because assumptively that demanding credit is purpose-oriented and the purpose of demanding credits is finite as well.

The money demand function (23) is negatively dependent on the stock market rate of return (m^D_e<0). As the stock market return rises ($de > 0$), the demand for stocks becomes more attractive than the demand for money. In turn, this leads to a fall in the money demand.[18] The money demand coefficient exhibits a negative dependence on the tax on the savings account ($m^D_{t_{SAV}}$<0) because a rise in the tax would make holding money (in the form of D_{SAV}) less attractive. The coefficient is positively dependent on the risk parameter ρ (m^D_ρ>0)[19], because a relatively higher risk would lead to a less risky form of investment, hence the money demand is assumed to rise. k^D is assumed to be independent of ρ because the risk in the system will not affect the demand side of the credit market. Moreover, the coefficient is positively dependent on the national income (m^D_Y>0); this holds due to the positive relationship between the national income (which increases the

[18]According to the Islamic banking principles (Table 1) money is not regarded in its store of value function, which is also emphasized by the respective taxes in the system (t_{SAV} and t_{ER}). Nevertheless, it is conceivable that the agents in the system based on portfolio-theoretical considerations still hold money. Therefore money M^D has to have a relationship with e.

[19]In Table 1, it is described that in Islamic banking, money is only regarded as a medium of exchange. Nevertheless, in the course of modeling, it was preferred to determine the actors to make the changes in e and ρ into account as they determine their money demand. The finding is in line with the Keynesian liquidity preference theory.

transaction volume) and the demand for money.

$$A^S = P_A(A_{ICB} + A_{IB} + A_{HH}) \Leftrightarrow \tag{24}$$

$$A^S = P_A\overline{A} = \frac{Div}{e}\overline{A} \tag{25}$$

The stock supply in the Keynesian Islamic banking model happens to have a fixed stock size. The high-income COs are the only group of agents who can issue (and thereby refinance themselves through) stocks. Nevertheless, the stock supply is limited in their number; thereby, it is presumed that they have enough means of finance and do not require issuing stocks. The possession of the stocks is divided between three types of agents A_{ICB}, A_{IB} and A_{HH}[20] in the system (equation (24)), and the nominal supply for stocks depends on the dividend yield e, which is inversely related to the asset price $P_A A$ (equation (25)) because the dividend is assumed to be constant. Hence, the nominal supply A^S only changes in case of value-related changes (because of P_A and not $\overline{A}$). If equation (21) is considered, then the negative dependence on the stock market return (f_e^S <0) is not because of the change in the absolute numbers of stocks. Instead, it has to be interpreted as a change in the value of A^S.[21]

After the respective functions of the three markets (money/credit/stocks) are derived, the model can be reduced to the following system of equations, where initially, an equilibrium (with $e = e_0$) on all markets is assumed:

$$\begin{aligned} M_0^S &= m^S\left(\overset{(+)}{e_0}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}\right) B_m^x \\ &= m^D\left(\overset{(-)}{e_0}, \overset{(-)}{t_{SAV}}, \overset{(+)}{\rho}, \overset{(+)}{Y}\right) = M_0^D \end{aligned} \tag{26}$$

$$\begin{aligned} K_0^S &= k^S\left(\overset{(-)}{e_0}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}\right) B_m^x \\ &= k^D\left(\overset{(+)}{e_0}, \overset{(+)}{Y}\right) = K_0^D \end{aligned} \tag{27}$$

$$\begin{aligned} A_0^S &= P_A\overline{A} = f^S\left(\overset{(-)}{e_0}\right) \\ &= f^D\left(\overset{(+)}{e_0}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}\right) B_m^x = A_0^D \end{aligned} \tag{28}$$

The system is sketched in figure 3 in three separate graphs. The critical difference to the conventional way of sketching the markets lies mainly in the caption of the vertical

[20] The stocks in the hands of the HHs are not visible in the equations or balance sheets, because the underlying transactions consist of transactions between non-banks. For details, see subsection 3.3.1.

[21] Suppose that P_A rises, then it leads to a fall in e. That is why the negative relationship between f^S and e holds.

axis (stock market return e replaces the interest rate i). In contrast to the conventional market approach, the slopes of the credit demand and supply lines are switched. In the conventional approach (where e is replaced by i), the credit supply is positively, and the credit demand is negatively sloped.

In the stock market, the stock supply is negatively, and the stock demand is positively depicted because the stock market return is defined as a dividend yield ($e = \frac{\text{Dividends per stock}}{\text{stock price}}$) and not as a stock price. Further attention to this topic will be drawn in the analysis.

The money market is represented by the intersection of the M^S/M^D lines at Q_0 (M_0/e_0). The credit market has its equilibrium at Q_0 (K_0/e_0) where the K^S/K^D lines intersect. The stock market is at equilibrium point Q_0 (A_0/e_0) where A^S/A^D cross.

In the initial state, assumptively, all three markets are in equilibrium and correspond to one price. It has to be emphasized that this state is only defined as a starting point and not an intuitive market outcome. The equilibrium value e_0, in this case, can not be understood as a perfect substitute for the interest rate as a price mechanism to bring all three markets (in the long run) into equilibrium at once (according to Walras' Law). In a typical conventional three-markets model, two mechanisms (loan interest rate and bond interest rate/return on real capital) usually bring the three markets (money/credit/bond/real capital market) into equilibrium. The following will exemplify that the system (26)-(28), as a result of shocks, will typically display disequilibria, both in the money and credit market.

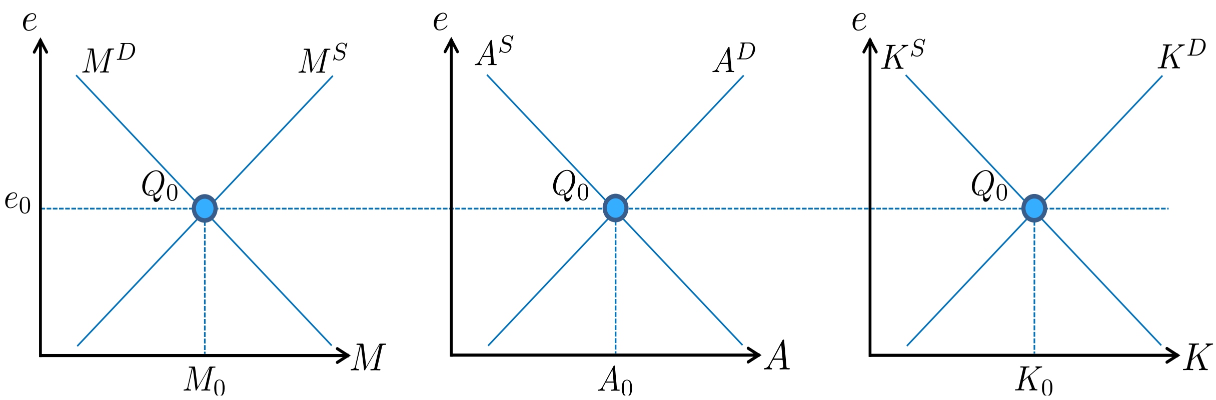


Figure 3: Initial equilibrium (three-markets model)

3.3 Parametrization and Results (Three-Markets Model)

This subchapter shows how the Keynesian Islamic banking model (comprising money, credit, and stock market) reacts to changes in relevant variables. The focus is on two shocks:
A change in the exogenous monetary base ($dB_m^x > 0$) and in the tax levied on excess reserves ($dt_{ER} < 0$). These are two monetary policy instruments worth analyzing because it shows how the model reacts to the shocks.
An overview of the other shocks and their impacts on the markets will be provided in a further step.

3.3.1 Rise in the Monetary Base ($dB_m^x > 0$)

An increase of the exogenous monetary base $dB_m^x > 0$ can be exemplified by an increased purchase of Islamic government bonds B_{GOV} by the Islamic central bank. According to the Keynesian Islamic banking model (cf. figure 2), the transaction is divided into two steps (compare with subchapter 3.1.3). In the first step, the IB receives B_{GOV} in exchange for D_{SAV}. In the following step, IB gives B_{GOV} to the ICB in exchange for ER. Through the increase in ER, the exogenous B_m^x rises (cf. equation (5)).
The analysis is divided into two parts. First, the primary effect, in which the immediate reactions of the markets to the shock, will be explained. Second, in the secondary effect, there will be the price reaction and the convergence towards the outcome.
In the primary effect, the increase of B_m^x is comparable to the conventional banking system's buyout of assets/bonds (open market operation). It results in more liquidity available to the system, assuming that all three markets benefit (from the increase in liquidity). The increase in B_m^x in figure 4 analytically leads to an expansion of

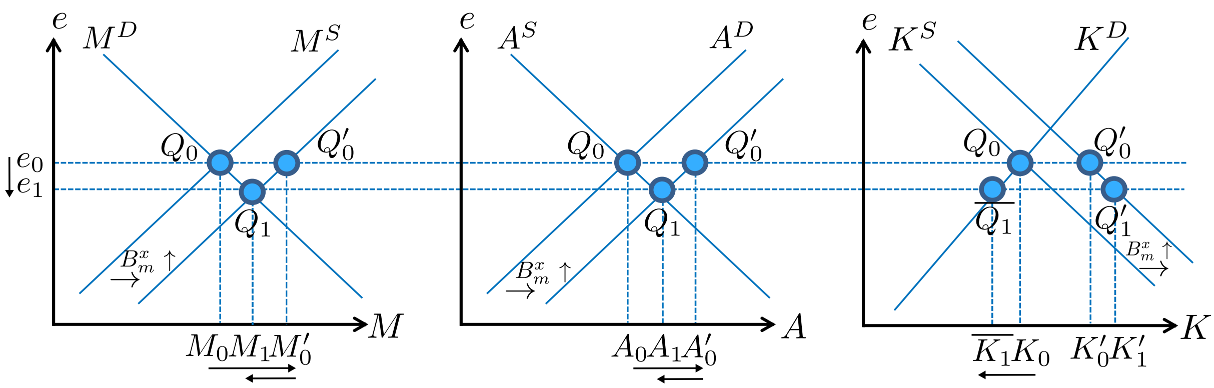


Figure 4: Rise in the monetary base

the markets, this is noticeable via a graphical rightward shift of the money supply ($dM^S > 0$), the demand for stocks ($dA^D > 0$), and the supply of credit ($dK^S > 0$). At a constant e_0, the three markets exhibit a disequilibrium at Q_0'. Q_0' is the amount that could be the transaction volume in the respective markets but is not achieved because of the divergence between demand and supply. In the stock market, excess demand is observable ($A'_0 - A_0$). The amount of tradable stocks is determined by the shorter market side ($A_0 = \overline{A}$). The money and credit market in this setup become passive[22] markets, in which an excess supply results respectively. The transaction volume of credits is determined by the shorter market (demand) side K_0. The money market supply is at M'_0. The demand side stays at its initial value of M_0.

In the secondary effect, the stock market becomes crucial because it is the only market that has a market-clearing price mechanism. The money and credit markets react to the stock return $e = \frac{Div}{P_A}$, but the price does not unleash its market-clearing power. Excess demand in the stock market leads to a stock price reaction, which leads to a rise in the stock price ($dP_A > 0$). Since the dividend yield is inversely related to the stock price $e = \frac{Div}{P_A}$, the dividend yield will decrease ($de < 0$) given that the dividend per stock stays constant. The drop in the dividend yield e_0 to e_1 will affect all three markets. The fall in e leads (given equation (1)) to a rising tendency of D_{SAV} to the disadvantage of D_{INV}. Rising D_{SAV} means that more tax will be levied on the capital in the deposit ($t_{SAV}D_{SAV}$). Less capital will be available to invest. On the supply side, A^S will rise as a reaction to the fall in e. A fall in e is based on a rise of P_A. A^S is defined as $P_A\overline{A}$, a rising P_A leads to an increase in A^S. The rise in A^S is only in terms of value, not in the actual numbers of stocks ($\overline{A}$ stays fixed). On the demand side, A^D means that a fall in stock return reduces the incentive to invest in stocks. Graphically, supply is at Q_0 and demand at Q'_0. From these points, they converge towards equilibrium point Q_1. As a result, the final value is greater than the initial value traded on the stock market ($A_1 > A_0$). A similar adjustment process can happen in the money market; in figure 4, a convergence towards equilibrium at Q_1 is visible. A fall in e leads to a rise in M^D. Because relatively more attractive than investing in stocks. In the case of M^S, the fall in e means that supplying money becomes less attractive because, as explained before, the IB observes e and changes the money supply accordingly. Graphically this means that from Q_0 and Q'_0 on, there is a convergence process towards Q_1 ($M_1 > M_0$). It has to be emphasized that the equilibrium result on the money market (figure 4) is represented by Q_1 constitutes an exception. As explained before, the money market is not brought into equilibrium by e in every case. Certain conditions have to be fulfilled to end up in an equilibrium. The more likely results in the money market (excess supply and excess demand) are illustrated in figure 9 (in the appendix (A.4)).
The condition that has to be fulfilled in order to facilitate equilibrium in the money market is:

$$\varepsilon_{A^D,e} - \varepsilon_{A^S,e} = \varepsilon_{M^S,e} - \varepsilon_{M^D,e} \tag{29}$$

[22]The stock market return e is not supposed to bring the money and credit market into equilibrium.

where the symbol ε stands for elasticity and $\varepsilon_{A^S,e} = -1$. The condition requires that the difference between the responsiveness of stock demand and stock supply to e has to be equal to the difference between the responsiveness of money supply and money demand to e (cf. figure 4). The money market exhibits an equilibrium on the same e level (e_1) as the stock market. The detailed derivation is in part A.4 of the appendix). The condition for any disequilibria in this setup is:

$$\varepsilon_{A^D,e} + 1 \neq \varepsilon_{M^S,e} - \varepsilon_{M^D,e} \tag{30}$$

The supply side of the credit market rises when e falls. If the stock return falls, there is a higher incentive to supply credits. Instead, the demand side falls due to falling e because the incentive to invest in stocks with borrowed capital becomes weaker. Graphically, the excess supply gets wider, where the demand side goes from point Q_0 to $\overline{Q_1}$ and the supply side from Q'_0 to Q'_1. Finally, the system results at $\overline{Q_1}$ in a demand-sided rationing $\overline{K^D}$. This means, in other words, that the market results in a buyer's market constellation as buyers/demanders are served fully. The amount of demand for credit in the system decreases (from K_0 to $\overline{K_1}$).

In conclusion, it can be said that an increase in the exogenous monetary base ($dB^x_m > 0$) leads to an increase in the amount of money and stocks[23]. A decrease in the transaction volume of the credit market arises. It is evident that there is a tendency that an expansionary monetary policy leads to growth in the respective markets. The credit market is assumed to be less potent in the Islamic model. Presumptively, the effects should be manageable for the Islamic economy. However, that is something a potential ICB needs to keep a very close eye on. Another interesting aspect of the analysis of this model is the importance and dynamics of the deposits, which plays a minor role in basic conventional models.

The algebraic solution of a rise in the monetary base and the conditions under which the money market gets to equilibrium is described in A.4 of the appendix.

[23]The increase in stocks is only valuation-related. The number of stocks stays constant in the market ($A = \overline{A}$) as assumed before.

3.3.2 Reduction in the Tax on Excess Reserves ($dt_{ER} < 0$)

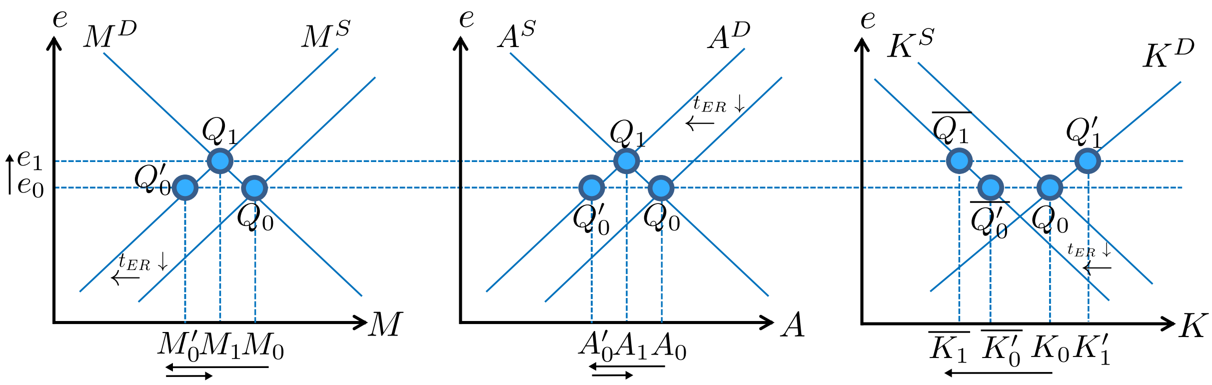


Figure 5: Reduction in the tax on excess reserves

As the tax on excess reserves falls ($dt_{ER} < 0$)[24] the direct consequence is that the IB expands the holdings of ER at the ICB. Practically, it can be interpreted as reducing the negative interest rate on excess reserves. That interest rates can become negative is not all too unusual at least since the ECB introduced negative interest rates (ECB (2014)), which remained effective until July 2022.

The shock analysis in the following consists of a primary and a secondary effect.

In the primary effect, the tax cut impacts all three markets negatively because the incentive for an IB to hold ER has increased compared to providing credit, holding money, or buying stocks. Graphically, this means that in the money market, the supply of money shifts to the left ($dM^S < 0$), resulting in a temporary excess demand at Q'_0 ($M_0 - M'_0$). In the stock market, the demand for stocks ($dA^D < 0$) shifts to the left resulting in a temporary excess supply at Q'_0 ($A_0 - A'_0$). In the case of the credit market, the credit supply shifts to the left ($dK^S < 0$), resulting in excess demand at $\overline{Q'_0}$ ($K_0 - K'_0$).

In the secondary effect, the developments in the stock market determine the final result in all three markets. An excess supply in the stock market leads to a deterioration of the stock price ($dP_A < 0$), which (at given constant dividends) leads to an increase of the dividend yield ($de > 0$) until the new level e_1 is reached. The stock market moves along the A^S and A^D lines towards its equilibrium point Q_1. The supply of stocks falls due to valuation ($(P_A\overline{A}) \downarrow \rightarrow A^S \downarrow$). The demand instead rises due to the rising e because higher stock return increases the willingness to invest in stocks. Overall the stocks decrease in value ($A_1 < A_0$). The money markets' excess demand is removed through the increase in e by the convergence of M^S and M^D lines, respectively, towards a new equilibrium. The money demand falls because holding money becomes less attractive due to rising stock returns. The supply-side rises because the IB observes e and reacts. In

[24] The reduction of the tax on excess reserves has some implications on the corrected monetary base. The conditions keeping B_m^x constant are explained by equation (5) (in subchapter 3.2).

this case, the final equilibrium Q_1 is not necessarily the only result in the money market. e is the only price in this model; hence only one market (out of three) is assumed to get definitively into equilibrium, namely the stock market. Similar to the increase in the exogenous monetary base (subsection 3.3.1), it is possible to show (graphically: figure 5 and algebraically: appendix A.5) that equilibrium in the money market is feasible. The following condition therefore must be satisfied:

$$\frac{M_e^D - M_e^S}{M_{t_{ER}}^S} = \frac{A_e^S - A_e^D}{A_{t_{ER}}^D} \tag{31}$$

For any disequilibrium on the money market ($M_0 > M_1$ or $M_0 < M_1$) condition (31) is violated. The overall amount of money in the market falls ($M_0 > M_1$). In the case of the credit market (similar to $dB_m^x > 0$) no equilibrium is achieved at $\overline{Q_1}$. Instead of a widened demand-sided rationing, as a result, a widened supply-sided rationing $\overline{K^S}$ is attained, which means that credit supply is served fully and the credit demand faces shortages. The rising stock return e leads to a lower incentive for IBs to supply credits. The credit demand instead rises because the higher stock return unleashes higher stock demand, which is to be financed by borrowed capital. The amount of credit is pushed back from K_0 to the final amount $\overline{K_1}$.

The overall effect shows that the incentive to increasingly hold ER by cutting t_{ER} leads to a fall in all three markets. Analyzes in conventional models come to similar results when the reduction of the penalty interest on ER is examined there. In both models, the aim of the penalty interest is to prevent the money from being horded by commercial banks and, in the best case, to support the money circulation. The decisive differences in the effectiveness of this monetary policy instrument are twofold. On the one hand, the credit market produces a disequilibrium (in the Islamic Keynesian version). Moreover, on the other hand, the tax on ER (in the Islamic Keynesian version) enables the ICB to redistribute the received funds ($T_{ER} = t_{ER}ER$) as "good loans" for example. The algebraic solution of the effect of $dt_{ER} < 0$ is in A.5 in the appendix.

3.3.3 Analysis of the Remaining Shocks

Table 4 provides an overview of possible shocks hitting the Keynesian Islamic banking model. In the first column, all shocks are listed with positive and negative signs. In the first row of the table, all results are observable. de, dM, dA and dK represent the changes in the respective endogenous variables. Expansive effects are marked with a plus (+), contractive effects are marked with a minus (−), and neutral effects are marked with zero (0). EQ_M, EQ_A, and EQ_K stand for the equilibrium in the respective markets (money, stock, and credit market). The checkmark symbol (✓) stands for results, in which an equilibrium is at least likely. The checkmark symbol in the case of the stock market stands for an equilibrium result that is guaranteed. In the case of the money market, instead, an equilibrium result can be achieved under conditions specified in subchapters 3.3.1 and 3.3.2. The cross mark symbol (X) stands for results, in which an equilibrium is at least unlikely. The cross mark symbol in the context of the credit market represents a result in which no equilibrium is possible. This has been explained before on the credit market. On the credit market rationing results are the rule due to the absence of an equilibrium price. The cross mark symbol in the case of the money market stands for an equilibrium result that is unlikely but still possible. The shocks S, t_{ER}, ρ, and B_m^x show

Table 4: Overview of possible shocks in the three-markets model

Shocks	de	dM	dA	dK	EQ_M	EQ_A	EQ_K
$dS > 0$	−	+	+	−	✓	✓	X
$dS < 0$	+	−	−	−	✓	✓	X
$dt_{ER} > 0$	−	+	+	−	✓	✓	X
$dt_{ER} < 0$	+	−	−	−	✓	✓	X
$d\rho > 0$	+	−	−	−	✓	✓	X
$d\rho < 0$	−	+	+	−	✓	✓	X
$dB_m^x > 0$	−	+	+	−	✓	✓	X
$dB_m^x < 0$	+	−	−	−	✓	✓	X
$dt_{SAV} > 0$	−	−	+	−	X	✓	X
$dt_{SAV} < 0$	+	−	−	−	X	✓	X
$dY > 0$	0	0	0	0	X	✓	X
$dY < 0$	0	−	0	−	X	✓	X

differences in their economic interpretation but are the same in their graphical results. Since previous subchapters discuss these shocks in detail. The reader is recommended to loop up subchapters 3.3.1 and 3.3.2. The t_{SAV} shock instead has some unique properties and turns out to be an effective monetary policy tool. In comparison to t_{ER}, which has similar effects on the model, the t_{SAV} shock even influences the money demand. Given, a change in dt_{SAV} is combined with a change in income dY. It is even possible to counterbalance the credit market, which otherwise would end up in disequilibrium. The positive income effect ($dY > 0$) has no influence whatsoever on the respective markets.

This does not indicate that the markets remain untangled. The demand for money and credit is changing here too, but since the stock market stays untouched (from the income effect), there are no adjustments to the stock return e. That, in turn, leads to rationing in the money and credit circulating in the system.
It becomes clear that the three-markets model has to be expanded by a classic IS curve because the effect of Y indicates that the goods market can take on a stabilizing function in the model.

3.4 Model Extension (Explicit Goods Market)

The model so far showed the dynamics of the financial markets (money, credit, and stock market). The goods market was mentioned in the three-markets model in M^D and K^D implicitly as a shock parameter Y. In this subsection, the aim is to include an explicit goods market in order to see how repercussions from the goods market improve or worsen the results from a change in B_m^x, t_{ER} and other shocks. In a further subchapter an overview over all other possible shocks in the four-markets model will be presented. It is known from the three-markets model that the income effect can stabilize the system. In order to create a transmission channel from the financial/monetary sector to the real economy, the macroeconomic portfolio theory (Tobin (1969)) and the neo-quantity theory (Brunner and Meltzer (1972)) serve as inspirations to develop a four-markets model.
In the three-markets model, the stock market (A) stood for any partnership-based contract, the preferred type of contract in Islamic banking (as mentioned before). This market also accounts for tangible assets (physical goods such as machinery, production plants, and real estate). The broader market will be called as "real capital market" and abbreviated as A^+. There will be an investment parameter in the upcoming formulation of the goods market, and the investment decision will be causally dependent on Tobin's q. From the primary literature of macroeconomics (e.g., Jarchow (2010, p. 118)) and Mankiw (2011, p. 622)) it can be learned that Tobin's q depends on the current stock of real capital and also on future potential returns on real capital. Hence, it is considered a valid assumption to view the stock market as an indicator of development in the market for real capital. According to Burda and Wyplosz (2009, p. 247), the stock prices are the market's best estimate of current and future earnings out of real capital. The components of Tobin's q will be elucidated step by step. Assumptively, in the following all agents accept COs namely ICB, IB and HH (A^+_{ICB}, A^+_{IB} and A^+_{HH}) are assumed to hold real capital.
Instead of the dividend yield e as the return/price of this market, the return is indicated by r, the return of the real capital (including stocks as a representative of tangible assets). Similar to the stock market, the real capital market has a fixed size $(A = \overline{A^+})$[25] in order to keep things tractable. The return on real capital is defined as:

$$r = \frac{E^n}{P_{A^+}} \tag{32}$$

[25]In the following, it is assumed that the amount of existing real capital is constant. Nevertheless, in the course of the analysis, investment will grow and additional real capital will emerge. This is possible if the expression Marginal Efficiency of Capital (MEC) used by John M. Keynes himself is considered. Keynes regarded the internal rate of return synonymous with the MEC. This term is intended to express that the investments made in a period are small compared to the existing real capital and therefore increase it only marginally (Wohltmann, 2016, p. 121).

The return on real capital depends on E^n the net return of the available real capital (stocks and tangible assets) per period and on P_{A^+}, which is the price of real capital. E^n is assumed to be fixed over time $E^n = \overline{E^n}$ (no technological progress).
After defining the return on real capital, there is a need for a transmission channel between the financial market and goods market. Therefore it is vital to elaborate on a transmission mechanism of a relative price that transfers monetary impulses to the goods market, which the macroeconomic portfolio theory can provide as a generalization of the traditional Keynesian approach (IS-LM Model).
In order to attain the relative price, the analysis has to go down to company level, in which the investor has to decide on the right amount of investment capital distributed between the most profitable investment projects. For this important decision, two variables are considered: R and r. Assume:

$$R \geq r \tag{33}$$

In this inequality formula, R stands for marginal efficiency of capital (the return on to be produced capital goods (new investments) is assumed to be constant for all future periods) and r for the return of existing capital goods (including the return on the stock market e). That shows that new investments are more profitable if the relation $R > r$ holds. In contrast to the conventional model, the planned investment project can also exhibit negative returns.[26] If the lifespan of the capital good is assumed to be infinite and the expected net return E is constant, then the marginal efficiency of capital R is:

$$R = \frac{E}{CP_0} \tag{34}$$

CP_0 stands for the initial cost of purchase for the investment.[27]
For convenience, in this model, there is no technological progress. Consequently, $E^n = E$ holds. Now it is possible to define a relative price necessary to transfer monetary impulses to the goods market. The relative price sets a relation between R (return on new (to be produced) real capital) and r (return on existing real capital). If $R \geq r$ is given, then additional investment is profitable. Hence, the classical investment hypothesis is defined

[26] In the Islamic banking system the interest rate is negative (it results from zero interest rate on D_{SAV} and additionally a tax on D_{SAV} ($t_{D_{SAV}}$)). If the other investment possibilities have a negative outcome, projects with negative returns could also become relatively profitable (portfolio approach).

[27] For the net present value NPV_0 as the difference between the present value of cash inflows and the present value of cash outflows over a period of time in case of an infinite lifespan of the capital good holds: $NPV_0(z) = (\frac{E}{1+z} + \frac{E}{(1+z)^2} + \frac{E}{(1+z)^3} + ...) - CP_0 \leftrightarrow NPV_0(z) = \sum_{j=1}^{\infty} \frac{E}{(1+z)^j} - CP_0 \xrightarrow{i \to \infty} NPV_0(z) = \frac{E}{z} - CP_0$

as:

$$I = I(q) \quad \text{with} \quad \frac{dI}{dq} > 0 \quad \text{and} \quad q = \frac{R}{r} \tag{35}$$

The relative price q stands for Tobin's q. It exhibits the relationship between two rates of return: R is the ratio of return of new (to be produced) capital goods and r the rate of return of already produced capital goods (Tobin (1969) and Duwendag et al. (2014)). The investment function (35) is only dependent on q. In the course of this chapter, other variables will be presented that are important to the investment function (cf. (36) and (38)).

The goods market follows the traditional Keynesian approach. The aim is to set up an IS equation,[28] which equates the demand and supply side of the goods market (Y^D and Y^S). In order to be consistent with other assumptions[29] of the Islamic banking model there has to be a differentiation between high-income $Y^{D,H}$ and low-income $Y^{D,L}$ non-banks (HHs and COs) on the demand side of the goods market:

$$Y^{D,H} = C\left(\overset{(-)}{q}, \overset{(+)}{W}\right) + I\left(\overset{(+)}{q}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}\right) + G \tag{36}$$

or in compact representation:

$$Y^{D,H} = y^{D,H}\left(\overset{(+)}{q}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}, \overset{(+)}{W}, \overset{(+)}{G}\right) \tag{37}$$

The goods demand function of the high-income non-banks follows the structure of a typical goods demand function. Durable consumption goods C have a negative relationship with q ($C_q < 0$), since the increase in q provides a greater incentive to invest, it probably causes consumption to fall. Overall, the investment effect I_q should be larger than the consumption effect C_q in equation (37), thus the total effect $y_q^{D,H}$ should be positive. A falling r over a rising $q$and a declining consumption C leads to weaker demand for holding A^+ and increases the demand for durable consumption goods. C has a positive relationship with wealth ($C_W > 0$) since a higher level of wealth in the system is expected to result in a higher level of consumption demand. Wealth according to equation (38) is

[28] The IS equation in the four-markets model becomes crucial. Because it contains both, the demand for consumption goods and the demand for investment goods. The IS equation of the baseline New Keynesian Macroeconomics Models usually only contains the demand for consumption goods. Nevertheless, IS equations do exist, which consider capital and investment directly, such as the dynamic stochastic general equilibrium models (compare with, e.g., Smets and Wouters (2002)).

[29] This includes all assumptions that facilitate the reallocation of financial means surrounding the concept of *zakat* (especially the wealth taxes t_{ER} and t_{SAV}).

defined as the sum of money, government bonds, and the value of real capital.[30]

$$W = B_m^x + B_{GOV} + P_{A^+}A^+ \tag{38}$$

The investments are positively dependent on q ($I_q > 0$) because if r falls, the opportunity costs change in favor of new (to be produced) capital goods (R is relatively higher than r). The investments I rise.[31] The investments are also positively dependent on t_{SAV} ($I_{t_{SAV}} > 0$) because if the tax rises, then keeping capital in savings accounts becomes less preferable than investing it. Hence, more capital is available for alternative forms of investments. The investments are negatively dependent on ρ ($I_\rho < 0$) because an increase in the stock and credit market risk would make alternatives such as holding riskless money more preferable.
The final part of the IS equation is government expenditure G, which is part of aggregate demand $Y^{D,H}$ ($y_G^{D,H} = 1$).

The low-income non-bank's goods demand is given as follows:

$$Y^{D,L} = C\left(\overset{(+)}{T_{SAV}}\right) + I\left(\overset{(+)}{q}, \overset{(+)}{\overline{K}}\right) = C\left(\overset{(+)}{t_{SAV}}D_{SAV}\right) + I\left(\overset{(+)}{q}, \overset{(+)}{\overline{K}}\right) \tag{39}$$

where T_{SAV} can be taken out of equation (6) and D_{SAV} is according to equations (2), (3) and (15):

$$D_{SAV} = \frac{1}{1+\alpha(\cdot)}M = \frac{1}{1+\alpha(\cdot)}m^S(\cdot)B_m^x \tag{40}$$

The consumption has a positive relationship with the tax on savings accounts ($C_{t_{SAV}} > 0$) due to the transfer effect.[32]
The investments positively depend on q ($I_q > 0$). The argument is similar to the case of high-income non-bank's goods demand equation (36).
In equation (40), there is α, which was initially defined in equation (1) and must be adjusted to the four-markets model.

$$D_{INV} = \alpha(\overset{(+)}{q}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho})D_{SAV} \tag{41}$$

[30]The real capital will be defined in the following passages.
[31]The high-income COs are assumed to finance their investments with stocks, which in the four-markets model are part of the real capital market. They are not dependent on credits as a form of financing.
[32]$t_{SAV} \uparrow \longrightarrow T_{SAV} \uparrow \longrightarrow C \uparrow$

As investments in the case of low-income COs are defined as exclusively debt-financed,[33] the investments are positively dependent on a binding rationing result $\overline{K}$ ($I_{\overline{K}} > 0$).[34] In case of a relaxation of the rationing barrier ($d\overline{K} > 0$), more credit supply/demand is available, and thereby the demand for the goods is positively affected.[35] The low-income

[33]The investments for low-income COs are credit financed because, in this model, low-income COs are not expected to emit stocks. Credits are the only way of refinancing their projects.

[34]Credit demand of the low-income COs is expected to be higher than the rationed credit supply ($K^D > \overline{K}$).

[35]The credit rationing is explicitly mentioned in the low-income investment function because it is assumed that they are not able to gain capital by emitting stocks or other securities. Only COs with high income can emit. That is why there is no rationing variable in the investment function of the high-income COs (cf. with equation (36)). Rationing on the credit market is considered to have a limited impact on investments in this model because the system prefers partnership-based (stock market) over debt-based (credit market) contracts. Therefore, the size of the credit market will fall short the stock market.

COs are struggling to survive; similar to the low-income HHs, they have no additional parameters which explain the change in investment demand. The investment demand of low-income COs does not follow the rationale of high-income COs.
The low-income households (as part of non-banks) receive their income from the sum of the tax on savings accounts (T_{SAV}). That is provided as a transfer payment or a "good loan" to them, which is consumed by the low-income non-banks as consumption C entirely and leaves no room for savings or investments. The change in the sum of the savings account (D_{SAV}) is crucial to low-income non-banks.
Now consider all variables on which $Y^{D,L}$ depends (including those relations displayed in the upcoming equation (51) or equation (19) respectively); then in compact representation, it writes as:

$$Y^{D,L} = y^{D,L}\left(\overset{(+)}{t_{SAV}}, \overset{(+)}{q}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(-)}{\rho}, \overset{(+)}{\overline{K}}, \overset{(+)}{B_m^x}\right) \tag{42}$$

An interesting aspect of equation (42) is its relation with the parameter q ($y_q^{D,L}$). Remember equations (39) and (40) then q influences equation (42) in conflicting directions ($I_q > 0$ and $C_q < 0$[36]. In equation (39) it is assumed that the low-income companies (as part of non-banks) invest more than they consume, so $I_q > 0$ will dominate and lead to $y_q^{D,L} > 0$.[37]
The behavioral equation of D_{SAV} follows from economic considerations. According to equation (3), D_{SAV} is part of the aggregated supply of money M, and M itself is dependent on B_m^x (see equations (16) and (51)). An increase in B_m^x has a positive impact on D_{SAV} ($D_{SAV\,B_m^x} > 0$) and C, which is a real balance effect (also known as the Pigou effect (Patinkin (1948, p. 556)).
t_{SAV} as part of T_{SAV} would lead to higher sum of T_{SAV}. There may be two opposite dynamics in place here. First, an increase in t_{SAV} would discourage the holdings in D_{SAV} and ultimately decrease T_{SAV}. Second, the increase in t_{SAV} may lead to the conclusion that a greater fraction of D_{SAV} is resulting in a higher sum of T_{SAV}. The second dynamic ($D_{SAV\,t_{SAV}} > 0$) has a positive relation with t_{SAV}. It is assumed that $y_{t_{ER}}^{D,L} > 0$ holds.
An aggregated goods demand is necessary to attain the IS equation after attaining the demand for the goods for both types of non-banks. As the two equations ($Y^{D,H}$ and $Y^{D,L}$) are added, the goods demand of the high-income non-banks is expected to dominate. It is assumed that the high-income non-banks dominate the low-income non-banks in terms of the size of demand ($y^{D,H} > y^{D,L}$) because the market is assumed to be highly unequal. Practically, this assumption is difficult to measure. However, according to Alvaredo et al.

[36] According to equation (40) $q \uparrow \rightarrow m^S \downarrow \rightarrow D_{SAV} \downarrow \rightarrow T_{SAV} \downarrow \rightarrow C \downarrow$ & $q \uparrow \rightarrow \alpha(\cdot) \uparrow \rightarrow \frac{1}{1+\alpha(\cdot)} \downarrow \rightarrow D_{SAV} \downarrow \rightarrow T_{SAV} \downarrow \rightarrow C \downarrow$ and according to equation (41) $q \uparrow \rightarrow \alpha(\cdot) \uparrow \rightarrow T_{SAV} \downarrow \rightarrow C \downarrow$ holds.
[37] It is important to differentiate between households and companies in the case of non-banks. Households do not save and instead consume all their received transfer payments. Companies, in contrast, invest more than they consume.

(2018, p. 24), the inequality in income distribution in the middle east is the highest in the world.[38] The aggregated goods demand $Y^{D,A}$ is given as follows:

$$Y^{D,A} = Y^{D,H} + Y^{D,L} = y^{D,A}\left(\overset{(+)}{q}, \overset{(+)}{t_{SAV}}, \overset{(+)}{t_{ER}}, \overset{(-)}{\rho}, \overset{(+)}{S}, \overset{(+)}{\alpha(\cdot)}, \overset{(+)}{W}, \overset{(+)}{\overline{K}}, \overset{(+)}{B_m^x}, \overset{(+)}{G}\right) \tag{43}$$

The next step towards the final equation has to consider the supply of the goods:

$$Y = Y^S = Y^D \tag{44}$$

The goods market is assumed to be in equilibrium. $Y = Y^S$ stands for the assumption that any planned amount of goods supply is realized. And $Y^S = Y^D$ is the standard equilibrium condition that implicates that the supply side perfectly anticipates the demand side and no surpluses or shortages occur on the goods market. Possible rationing effects of the credit market are assumed to have a limited impact on the goods market equilibrium condition because of the prior elucidated assumption $y^{D,H} > y^{D,L}$. Consequently, the IS equation can be written as:

$$Y = y\left(\overset{(+)}{q}, \overset{(+)}{t_{SAV}}, \overset{(+)}{t_{ER}}, \overset{(-)}{\rho}, \overset{(+)}{S}, \overset{(+)}{W}, \overset{(+)}{\overline{K}}, \overset{(+)}{B_m^x}, \overset{(+)}{G}\right) \tag{45}$$

where repercussions of possible rationing effects of the credit market for the goods demand are limited (this is the so called Keynes case or Keynesian neoclassical equilibrium in terms of the Neokeynesian Theory (Felderer and Homburg, 2005)). Nevertheless, the easing of the rationed credit demand ($\overline{K} = \overline{K^S} < K^D$) has a positive (negligible) impact on overall investments I and goods demand of low-income ($Y^{D,L}$) COs.

For the setup of the other three markets (money, credit, and real capital market), Table 2 should be recalled, from which the balance sheets of the Islamic banking Keynesian model are depicted. The position on the balance sheets and the respective markets stays mainly the same. Because of this, the calculation of equations will be based on the calculations of subsection 3.2 and its linked appendices.

The stock market A instead needs to undergo some substantial changes because it has to be (as described earlier) replaced by a broader market, namely the real capital market A^+ (the market consists of stocks and tangible assets). The stock market embedded in the market for real capital in the four-markets model is defined to be fixed, whereby the stock market in the three-markets model had a fixed number of stocks. On the balance sheets, A_{ICB}, A_{IB}, and A_{HH}[39] have to be replaced by A^+_{ICB}, A^+_{IB} and A^+_{HH}. In the conventional

[38] In the study the region has been decomposed into five blocks by the authors: (i) Turkey, (ii) Iran, (iii) Egypt, (iv) Iraq, and Syria and other non-Gulf countries: Jordan, Lebanon, Palestine, Yemen), and (v) Gulf countries (including Saudi Arabia, Oman, Bahrain, UAE, Qatar, and Kuwait)

[39] A_{HH} is not visible on the balance sheet of non-banks because in the accounting process it cancels out (cf. Table 1).

four-markets model, banks do not hold tangible assets. Nevertheless, in order to facilitate A^+ the banks (ICB and IB) only hold stocks and no tangible assets). The NBs also hold both: stocks and tangible assets. In the balance sheet of the four-markets model, the A^+_{HH} is multiplied with its price P_{A^+}. The expression $P_{A^+}A^+_{HH}$ can be found on the asset side of the NB's balance sheet. For the supply side of the real capital market, the following is given:

$$A^{+,S} = P_{A^+}(A^+_{ICB} + A^+_{IB} + A^+_{HH}) \Leftrightarrow \tag{46}$$

$$A^{+,S} = P_{A^+}\overline{A^+} = \frac{qE^n}{R}\overline{A^+} = f^{+,S}\left(\overset{(+)}{q}\right) \tag{47}$$

For equation (47) equations (32) and (35) have to be considered and solved for $P_{A^+}(= \frac{E^n}{r} = \frac{q}{R}E^n)$. Similar to the fixed stock supply in the three-markets model $(A = \overline{A})$, the nominal supply of real capital is defined as a fixed term $\overline{A^+}$. The change in $A^{+,S}$ can only be brought about by its price P_{A^+}. As defined before, the real capital market consists of the inventory of physical goods such as machinery and stocks. The stock market is assumed to be flexible. However, an additional unit of stocks that the high-income companies can issue is so marginal that the total shares are hardly changed and assumed to be fixed. In principle, companies can issue stocks in the model, but it is assumed that a change in the supply of stocks can only occur in terms of value and not in terms of quantity. Now transfer the idea to the market for real capital, then it means that additional investments change the size of the market for real capital marginally, and thus the size of the market can be perceived as fixed, too. The changes in the size of real capital supply are here similar to the stock market A based on value changes through a change in P_{A^+}.[40] The main difference to the stock market A is that the high-income COs can emit stocks, but still, the overall size of the real capital market $\overline{A^+}$ stays the same.
An increase in q leads to an increase in the supply of real capital $A^{+,S}$ $(f^{+,S}_q > 0)$. The increase in q can be explained with the help of equations (32) and (35). Because if P_{A^+} rises, r must decrease, and that leads to the fact that at constant R new (to be produced) real capital becomes more attractive, and it provides an impulse to invest more in physical goods. An increased issue of stocks refinances the higher investments; but as it has been assumed that the number of stocks to be fixed, the supply of real capital remains constant. The only mechanism by which the value of real capital increases is the price mechanism P_{A^+}. Because of the rise of the price, according to equation (47), the real capital supply rises in value.

The demand for existing real capital is similar to equation (20). The major new

[40] The number of stocks can only be changed by high-income COs. Those with low-income are not able to emit stocks in this model.

parameter is the wealth effect W (cf. equation (38)). Furthermore, it can be re-written as:

$$A^{+,D} = f^{+,D}\left(\overset{(-)}{q}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}, \overset{(+)}{W}\right) B_m^x \tag{48}$$

If q falls then $A^{+,D}$ rises ($f_q^{+,D} < 0$), because q can only fall if the return on existing capital r rises. The rise in r would mean that investing in real capital (already produced capital goods) becomes more profitable than investing in new (to be produced) real capital. The demand for real capital is expected to rise if q falls ($dA^{+,D} > 0$).[41]

The wealth effect has a positive impact on the demand for real capital ($f_W^{+,D} > 0$).

Again, one has to bear in mind that the banks only demand stocks. The $A^{+,D}$ does not contain the demand for tangible assets. The same holds for E^n, which consists only of the stock return and is assumed to be constant.

The credit supply equation of IB (similar to equation (18))[42] is:

$$K^S = k^S\left(\overset{(+)}{q}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}\right) B_m^x \tag{49}$$

An increase in q increases the credit supply K^S ($k_q^S > 0$). A decrease in r (which leads to an increase in q) makes existing real capital relatively less profitable for an IB to invest in. The anticipated higher credit demand for financing purchases of real capital would increase the credit supply.[43]

The credit demand in the extended model reads as follows:

$$K^D = k^D\left(\overset{(+)}{q}, \overset{(+)}{Y}\right) \tag{50}$$

When q rises, then the credit demand K^D (of small COs) is expected to rise ($k_q^D > 0$) because the demand for investments rises.[44] q can only rise if r falls (R is assumed to be constant). That means that the return on capital goods to be produced R is relatively more favorable than the return on existing capital goods r. Hence, more credits are necessary for low-income COs to invest.[45]

The supply for money is given as follows (closely related to equation (16))[46]:

$$M^S = m^S\left(\overset{(-)}{q}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}\right) B_m^x \tag{51}$$

[41] The impact of the variables (accept W) on $A^{+,D}$ can be taken from equation (13) and its description.

[42] The approach is described in A.2 in the appendix.

[43] The impact of other variables on K^S can be understood from equation (12) and its description.

[44] The credit demand could be pushed by conflicting forces $C_q < 0$ and $I_q > 0$, but as it has been discussed in equation (42), the low-income non-banks are expected to invest more than they consume.

[45] The impact of other variables on K^D can be taken from equation (22) and its description.

[46] The approach of the derivation can be taken from A.1 in the appendix.

M^S rises if q falls ($m_q^S < 0$)[47] because if r rises (which implies a fall in q), then more capital is shifted towards the real capital market. The negative effect of the real capital market $f_q^{+,D} < 0$ is assumed to dominate the positive effect of the credit market $k_q^S > 0$ ($k_q^S < \left|f_q^{+,D}\right|$).[48] The dominance of the real capital market over the credit market is assumed because the market for real capital is expected to be bigger than the credit market (due to zero percent interest on credits) in the environment of an Islamic banking system. Like in the three-markets model the IB sets the money supply and carefully observes q and r. A falling r ensures that q must rise. In response it is reasonable to assume that IBs will lower the money supply.
The money demand in this extended model is given as follows:

$$M^D = m^D \left(\overset{(+)}{q}, \overset{(-)}{t_{SAV}}, \overset{(+)}{\rho}, \overset{(+)}{Y}, \overset{(+)}{W} \right) \tag{52}$$

The rise in q originates from a fall in r and an increase in the price P_{A^+}. The rising q leads to a rise in M^D ($m_q^D > 0$). That is since holding already produced real capital becomes less preferable, and the demand for money increases. The demand for money correlates positively with the income $Y(m_Y^D > 0)$. The Keynesian concept of transaction motive makes the money demand rise.[49] The demand for money rises with the rise of wealth ($m_W^D > 0$). The wealth effect is a new part of the money demand function in the four-markets model.

[47]As q originates from the stock market, banks do not have to hold physical goods/tangible assets. Every agent in this model holds stocks of the companies, which possess the physical goods such as machinery.
[48]The changes in the money market are attached to the changes in the credit market. In order to understand the impact of other variables on M^S, consider equation (12) and its description.
[49]Equation (23) explains the impact of other variables on M^D.

The four-markets model (money, credit, real capital, and goods market) can be written as an equilibrium set of equations, which depicts the initial state $q = q_0$ of the model:

$$\begin{aligned} M_0^S &= m^S \left(\overset{(-)}{q_0}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho} \right) B_m^x \\ &= m^D \left(\overset{(+)}{q_0}, \overset{(-)}{t_{SAV}}, \overset{(+)}{\rho}, \overset{(+)}{Y}, \overset{(+)}{W} \right) = M_0^D \end{aligned} \tag{53}$$

$$\begin{aligned} K_0^S &= k^S \left(\overset{(+)}{q_0}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho} \right) B_m^x \\ &= k^D \left(\overset{(+)}{q_0}, \overset{(+)}{Y} \right) = K_0^D \end{aligned} \tag{54}$$

$$\begin{aligned} A_0^{+,S} &= P_{A^+}\overline{A^+} = f^{+,S} \left(\overset{(+)}{q_0} \right) \\ &= f^{+,D} \left(\overset{(-)}{q_0}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}, \overset{(+)}{W} \right) B_m^x = A_0^{+,D} \end{aligned} \tag{55}$$

$$\begin{aligned} Y_0^S &= Y \\ &= y \left(\overset{(+)}{q_0}, \overset{(+)}{t_{SAV}}, \overset{(+)}{t_{ER}}, \overset{(-)}{\rho}, \overset{(+)}{S}, \overset{(+)}{W}, \overset{(+)}{\overline{K}}, \overset{(+)}{B_m^x}, \overset{(+)}{G} \right) = Y_0^{D,A} \end{aligned} \tag{56}$$

According to the structures of the equations (53) to (56) the system is visualized in figure 6. In contrast to the three-markets model, the dividend yield e has been replaced by Tobin's $q = \frac{R}{r}$ in the four-markets model. That leads to a change in the slope[50] of following functions: M^S, M^D, $A^{+,D}$, $A^{+,S}$ and K^S.

The money market is represented by the intersection of the M^S/M^D lines at Q_0 (M_0/q_0). The credit market for its part is represented by Q_0 (K_0/q_0) where the K^S/K^D lines intersect. Both sides of the market have a positive relationship with q. K^S is more sensitive to changes in q than K^D $(K_q^S > K_q^D)$ because it is assumed that the demand side considers q to a lesser extent in their decision making than the supply side. The real capital market is represented by point Q_0 (A_0^+/q_0) where the $A^{+,S}/A^{+,D}$ lines cross. The goods market is represented by the IS equation representing a function on which every single point constitutes an equilibrium in the goods market (such as Y_0/q_0).

The initial equilibrium in all four markets is a defined starting point for the model. It is just a stable departing point. q differs substantially from the interest rate in conventional models, which brings all markets into equilibrium according to the law of one price. This is not possible for q, which only brings the real capital market into equilibrium.

[50] Compared to slopes of the three-markets model.

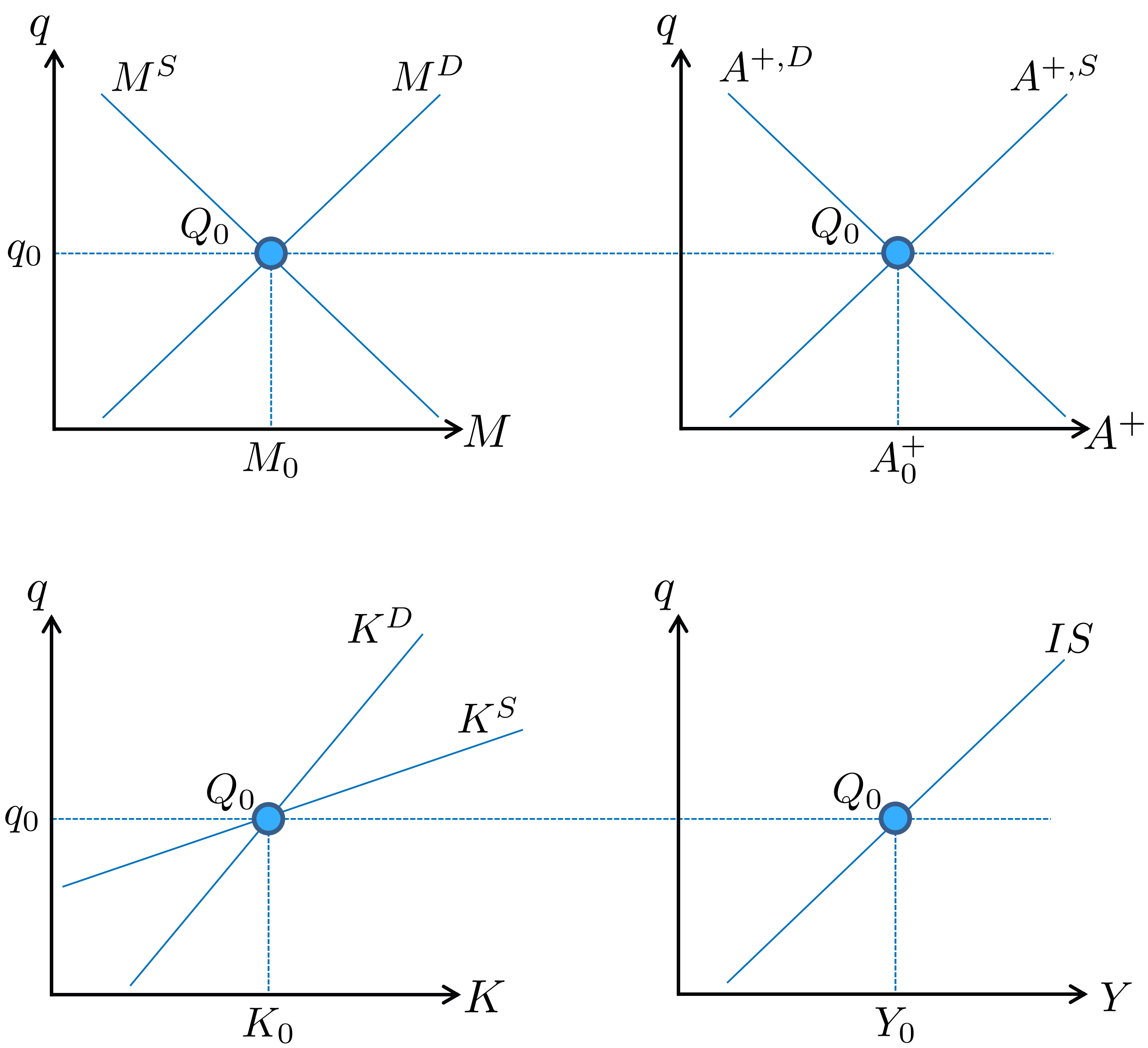


Figure 6: Initial equilibrium (four-markets model)

3.5 Parametrization and Results (Four-Markets Model)

This subchapter compares the reactions of the three-markets model with the reactions of a four-markets model regarding an increase in the monetary base ($dB_m^x > 0$) and a decrease in the tax on excess reserves ($dt_{ER} < 0$). Similar to the three-markets model, an additional subchapter will provide an overview of all exogenous variables (shocks) and their impact on the four-markets model. The notable feature of the four-markets model are the reciprocal economic repercussions between all four markets, but especially those of the goods market. Another important feature is the wealth effect (cf. equation (38)). This interaction between the markets is an outstanding element of the developed four-markets model and thus clearly distinguishes it from the three-markets model.
The analysis will consist of a primary and a secondary part. The primary part will briefly[51] deal with the consequences of the change in parameters and its implications (equilibrium/disequilibrium) in the respective markets Q_0 to Q_1. The secondary part will especially deal with the repercussions from the goods market, credit market, and wealth on the other three markets Q_1 to Q_2. Afterward, a table will follow, similar to Table 4 from the previous subchapter, analyzing the remaining shocks.

3.5.1 Rise in the Monetary Base ($dB_m^x > 0$)

A rise in the exogenous monetary base (through an open market operation)[52] results in additional available liquidity on the market, which will impact all markets. In the primary part (as observable in figure 7), the monetary policy shock $dB_m^x > 0$ leads to an expansion (graphically a right shift) of the money supply ($dM^S > 0$), the demand for real capital ($dA^{+,D} > 0$)[53], the credit supply ($dK^S > 0$) and the goods demand via real balance effect ($dY > 0$). At a constant q, there is excess demand in the real capital market, an excess supply in the money market, an excess supply in the credit market, and equilibrium in the goods market.
The occurrences in the goods market are interesting because money is not neutral in this model. The money market stimulated by an increasing B_m^x directly impacts the goods market via the real balance and indirectly via the wealth effect.[54]
The price in the four-markets model is now q (instead of e), which will only bring the real capital market (instead of the stock market) into equilibrium. Other markets may reach equilibrium, but it will not be through Tobin's q.
The natural response to excess demand on the real capital market is that its price P_{A^+}

[51] The primary part will be brief because the effects of the shocks are similar to the ones elucidated in the three-markets model.
[52] The details of the purchase of government bonds B_{GOV} can be taken from subsection 3.3.1.
[53] The real capital in the form of physical goods are held as stocks, so even banks can hold them.
[54] The effect is expected to be relatively small because the low-income households are assumed to be dominated by high-income households.

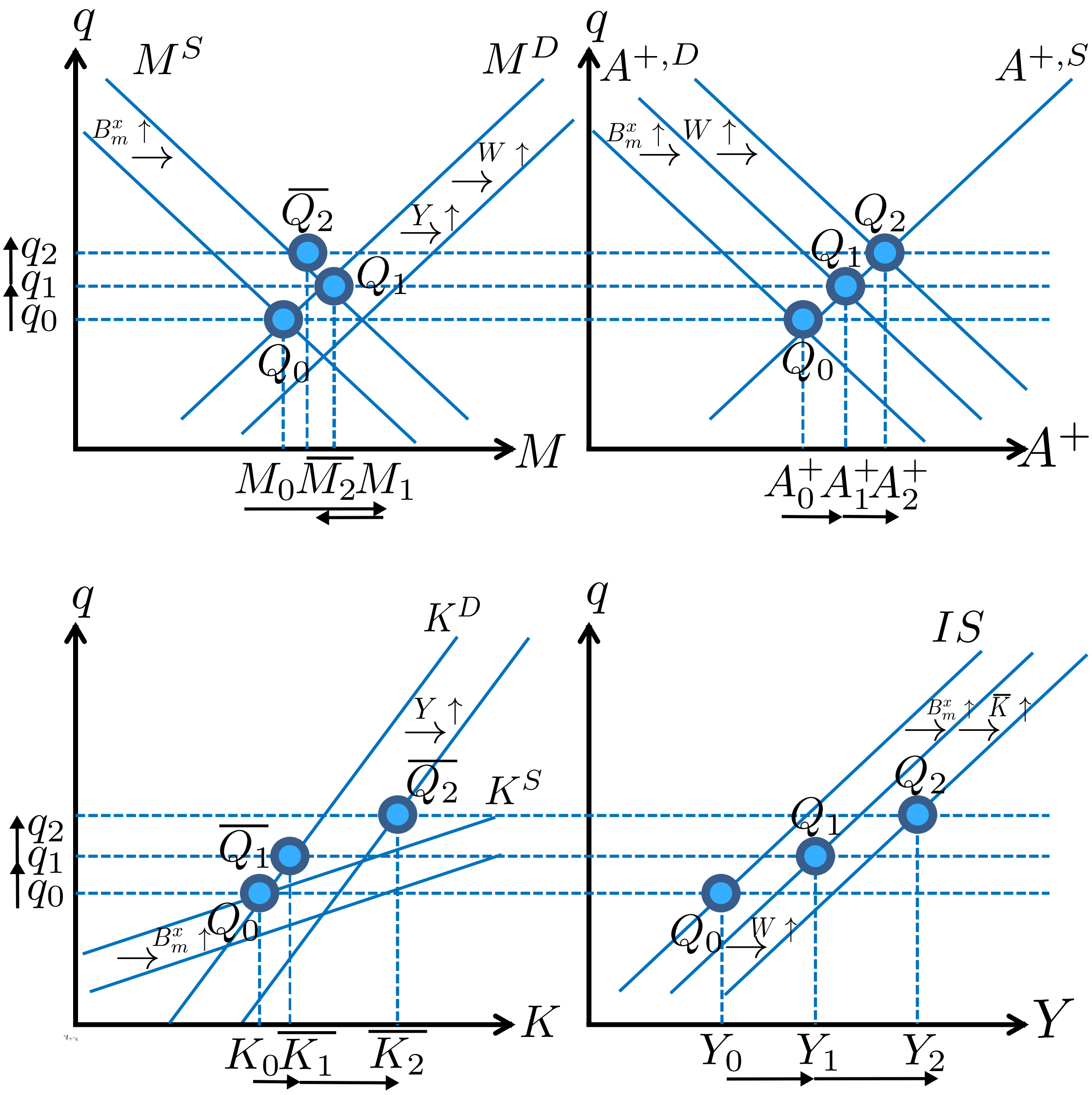


Figure 7: Rise in the monetary base (four-markets model)

has to rise. This leads to a decrease in r given that $r = \frac{E^n}{P_{A^+}}$ and ultimately to an increase in q from q_0 to q_1 (given that $q = \frac{R}{r}$) and R is assumed to be exogenous and constant. The increase of q (from q_0 to q_1) leads the market for real capital to a fall in demand, and due to falling r, investing in existing real capital becomes less attractive. It leads to a rise in supply because a rise of P_{A^+} increases the value of the supply side of the real capital market ($P_{A^+}A^+$). The rising q also stimulates higher issuance of stocks, but as the supply $\overline{A^+}$ is assumed to be fixed, no change in the number of stocks occurs. The increase in q now in the following will further affect the money, credit, and goods market. The increase in q can eliminate the excess supply on the money market through the decrease of M^S [55] and increase of M^D [56] until Q_1 is reached ($dM > 0$). However, as explained in the three-markets model in the money market, it is possible but not necessary to end up in equilibrium.

For the credit market, the rise in q leads over a rise in K^S [57] and a rise of K^D [58] to an excess supply. The credit market is at $\overline{Q_1}$ under rationing. The shorter market size determines the final amount of credit in the market $\overline{K^D}$, which leads to a rise in transaction volume (where $d\overline{K} > 0$, $\overline{K} = \min\left\{K^S; K^D\right\} = K^D$) meaning that more credit financed investment is possible although rationing prevails.

The goods market is the only market that stays in equilibrium ($Y^S = Y^D$) throughout since the supply side is assumed to perfectly anticipate the demand (with completely elastic quantity adjustment). The rise in q affects the IS equation in multiple ways.[59] These multiple effects on the goods market lead to higher goods demand and supply, hence to a higher income ($dY > 0$). That final point of this part is indicated by Q_1 (Y_1).

In the secondary part, two effects carry over from the primary to the secondary part: the wealth ($dW > 0$) and income effect ($dY > 0$).

For the wealth effect, consider equation (38). It is known that through the rise in B^x_m, the amount of money M has increased, and the value of existing real capital $P_{A^+}A^+$, too, and the number of government bonds B_{GOV} has fallen in the value of M under an expansionary open market policy. As a result, the wealth effect has to be positive, because the rise of M and the fall in B_{GOV} neutralize each other and ultimately the rise in value of the real capital $P_{A^+}A^+$ makes the wealth W rise. At a constant q, that means that the demand for money rises ($dM^D > 0$), the demand for real capital rises

[55] Where the IB observes the fall in r and adjusts M^S accordingly.

[56] Where the fall in r increases the demand for money (holding cash).

[57] Due to an anticipated increase in credit demand.

[58] Due to an increased demand for investing in real capital, low-income COs need more credits to finance them.

[59] According to equation (36), a rising q means in the context of the goods market two things for COs with high income. First, their consumption demand is stimulated, as a falling r drives demand for durable goods. Second, the investment demand for tangible assets found in the real capital market increases. According to equation (39), a rising q means for low-income COs that their investment demand is raised for the same reason as for high-income COs.

($dA^{+,D} > 0$), and the demand for goods rises ($dY^D > 0$), too.
The credit and money market are additionally influenced by the income effect, which leads to an increase in credit ($dK^D > 0$) and money demand ($dM^D > 0$), and the excess supply caused by $dB_m^x > 0$ is reduced through the income effect. The rationing on the credit market gets relaxed by the income effect ($d\overline{K} > 0$). As it is observable in figure 7, the IS curve benefits from the wealth effect (directly).
Graphically, the following changes arise in response to the income and wealth effect. M^D (excess demand), $A^{+,D}$ (excess demand), K^D (excess supply) and IS (equilibrium) will move to the right.
Excess demand on the real capital market forces P_{A^+} to rise, which leads to a fall in r and then to a rise of q (from q_1 to q_2). The rise in q makes the real capital market converge ($dA^{+,D} < 0$ and $dA^{+,S} > 0$) towards equilibrium in point Q_2.
A rising q creates a rationing result (excess demand) on the money market where $dM^D > 0$ and $dM^S < 0$, which results in $\overline{Q_2}$. The credit market experiences a relaxation of its rationing in $\overline{K_2}$ ($dK^D > 0$ and $dK^S < 0$) and is represented by $\overline{Q_2}$. Nevertheless, the amount of credit rises ($\overline{K_1}$ to $\overline{K_2}$). On the goods market, parallel to the influence of q, the credit rationing effect[60] also impacts $dY^D > 0$ resulting in Q_2.
Overall, the income and wealth effects positively impact the four-markets model. Principally the credit market benefits from the repercussions of the goods market but still ends up with a rationing result. As the supply of real capital rises, more stocks are emitted. Thereby a shift from debt-based finance to partnership finance is facilitated.[61] Although the money market ends up in excess demand, the overall amount of money (is expected to) increase.

Now, the next step is to assume that the risk parameter (ρ) also increases in response to the increase in the monetary base (B_m^x). To understand this, it is important to imagine the following:
The government (GOV) is running an unsustainable budget policy that results in a refinancing problem on the financial markets. This is similar to the case of countries in Southern Europe during the aftermath of the financial crisis in 2007/2008. They faced massive uptake of the risk premia on their bond interest rates, which could be translated as lacking trust in their issued bonds (or their capacity to repay their debt). The European Central Bank (ECB) reacted with a massive buy-out of their government bonds B_{GOV} (open market policy) in order to reduce the risk markup (ECB (2016)). The positive effects of an increase in B_m^x under certain circumstances can go hand in hand with the concern by bond investors that the GOV (due to the central bank intervention)

[60]The impact of the relaxation of the credit rationing is assumed to be small because it affects only low-income COs. As explained before, high-income COs dominate low-income COs.
[61]The idea is that large and credit-worthy COs can raise capital on the stock market, while small and less credit-worthy COs are still subject to the rationing on the credit market.

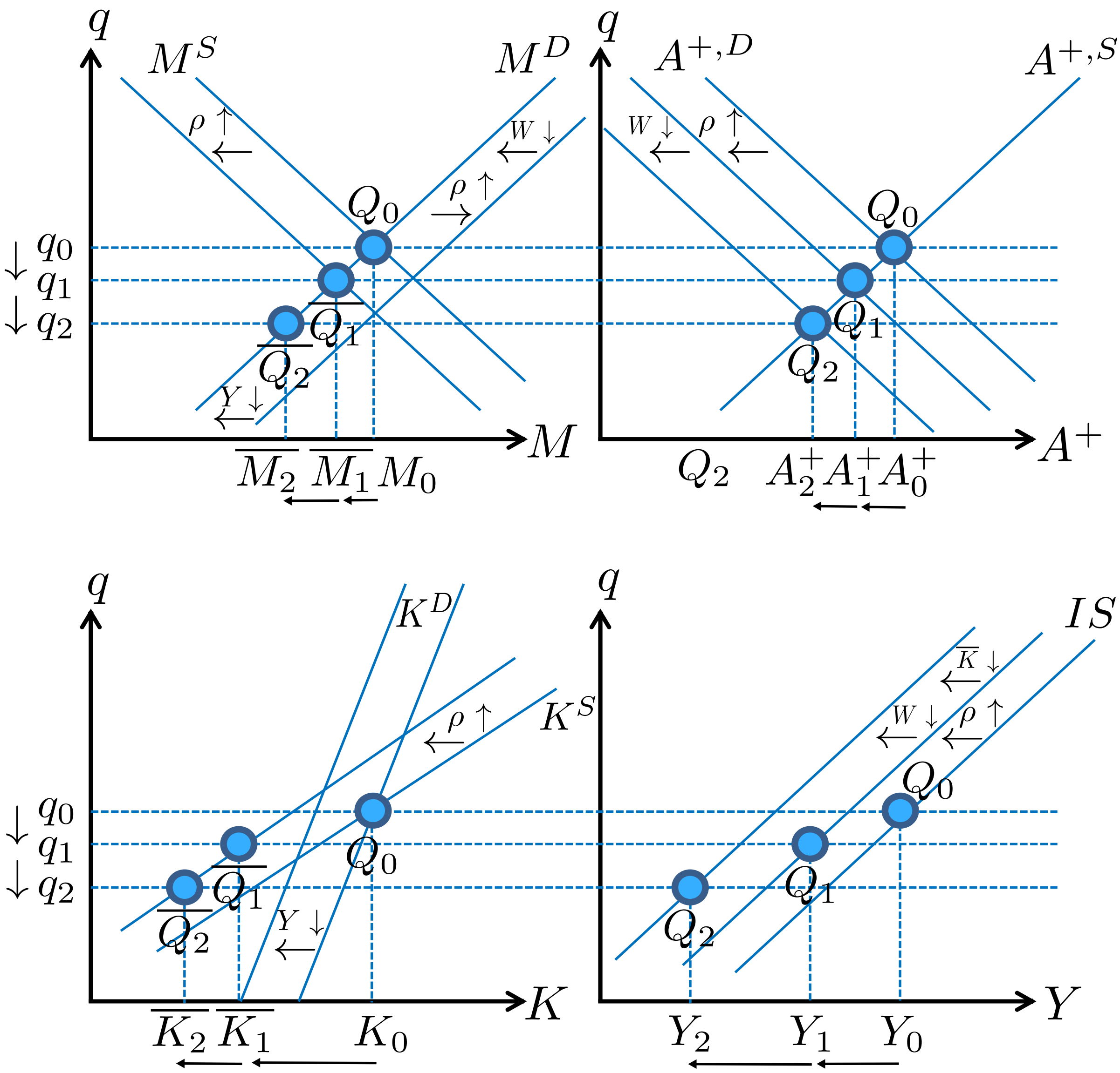


Figure 8: Rise in the risk parameter (four-markets model)

will not be incentivized to balance its budget. Rather investors would have to fear that in the medium to long term the GOV would not rein in its spending and that default on their loans would merely be delayed by central bank actions. The market might react with a further loss of confidence in the government bonds B_{GOV}, which can be translated as an increase in risk ($d\rho > 0$) in the system, where $\rho = \rho_{A^+} = \rho_{B_{GOV}}$ is assumed. In the following, the implications of a risk shock will be explained by referring to figure 8.
The increase in the risk has to be interpreted as an incentive to avoid relatively risky investment opportunities. That is reflected by (41), in which it is shown that more money will flow into D_{SAV} to the disadvantage of D_{INV}.
The shock $d\rho > 0$ leads in the primary part to a fall in $A^{+,D}$ (left shift). Beyond that, M^S is expected to fall (left shift), M^D is expected to rise (right shift), K^S and IS are expected to fall (left shift). On the goods market, a rise in ρ mainly affects the investment demand of high-income COs (see equation (36)). As there is an excess supply in the real capital market, a fall in P_{A^+} leads to a rise in r and eventually to a fall in q. The fall in q leads to convergence towards equilibrium on the real capital market Q_1. The overall amount of real capital is expected to fall ($dA^+ < 0$).
The positive risk shock leads to excess demand on the money market, and through the fall in q, the disequilibrium in the money market is at least reduced. The possible outcome, as graphically shown in figure 8 through $\overline{Q_1}$, remains an excess demand (M^S is the shorter market side). The total amount of money falls from M_0 to $\overline{M_1}$.
The credit market gets into an excess demand due to the risk shock. The fall in q makes the excess demand even larger. That leads to the rationing result of $\overline{Q_1}$ with the supply as the shorter market side $\overline{K^S}$. The total amount of credit falls to $\overline{K_1}$ ($dK < 0$).
The goods market reacts negatively to an increase in risk. The fall in q makes the loss in income even more severe $dY < 0$ (Y_0 to Y_1). The decrease in income can be explained by multiple effects.[62]

The secondary part starts with the repercussions from the wealth effect ($dW < 0$) and the income effect ($dY < 0$) of the primary part. The wealth (as it is defined in equation (38)) faces a negative net effect because in the primary effect, the amount of traded government bonds B_{GOV} in the market falls[63] and the value of real capital $P_{A^+}A^+$ falls also. The income effect arises from the result of the goods market (Y_0 to Y_1) in the primary effect.
According to figure 8 on the market for real capital, the contractionary wealth effect

[62]First, by equation (36), after which the fall in q leads to a decrease in investment I because high-income COs choose to invest less. Second, by equation (36), the fall in q leads to a fall in consumption because high-income COs choose to buy more durable goods. Third, according to equation (39), low-income COs choose to invest less.
[63]Through the buy-out of B_{GOV} by the ICB the amount of available/traded supply of bonds in the market falls.

leads to a left shift of the demand curve ($dA^{+,D} < 0$). On the money market, the effect of the risk shock on the demand side M^D is weakened by the wealth and income effects (left shift).
On the credit market, the immediate impact of the income effect is that the demand side K^D would shift to the left. Due to the wealth effect, the goods market also decreases ($dY < 0$).
Now, the market for real capital is in an excess supply. The price mechanism reacts and brings the real capital market into equilibrium point Q_2 by a further fall in q (from q_1 to q_2). That again starts a chain of reactions in the other three markets. The money market is in an excess supply by the fall in q, which makes the market move towards $\overline{Q_2}$. The fall in q enhances the excess demand on the credit market. The goods market also faces a further decrease (because of the fall in q and the negative credit rationing effect) in equilibrium output. The tightened rationing on the credit market ($d\overline{K} < 0$) reduces the demand in the goods market. Although this affects only low-income COs, the effect is still there and worth mentioning.
Overall, compared with the three-markets model, it can be seen that the income effect and the wealth effect reinforce the expansionary effects in the real capital market (which also includes the stock market) when the corrected monetary base is increased, and allow credit volumes to expand instead of contracting in the credit market. On the money market, there is practically no longer any prospect of equilibrium. The risk shock with its economic explanation leads at least to a damping of the positive income effect. As both effects coincide, the final effect of the rise in the monetary base will depend on the magnitude of the risk shock ρ in comparison to that of dB_m^x.

3.5.2 Reduction in the Tax on Excess Reserves ($dt_{ER} < 0$)

The reduction in the tax on excess reserves ($dt_{ER} < 0$)[64] is interpreted as an incentive to increase the holding of ER by IB and to decrease K^S. The tax itself is positively defined ($t_{ER} > 0$).
In the primary part of this shock analysis the focus will be on the graphical path from Q_0 to Q_1 (cf. figure 9). $A^{+,D}$ is expected to fall (left shift), M^S is expected to fall (left shift) and K^S is expected to fall either (left shift). From the mentioned three markets the capital is diverted towards the ICB as ER. The goods market is affected directly via the negative transfer effect[65] by the tax cut (IS shifts to the left).
The excess supply on the real capital market leads to a fall in P_{A^+}, a rise in r, and finally a fall in q (q_0 to q_1). Through the fall in q, the supply and demand side of the real capital

[64]The reduction of the tax on excess reserves has some implications on the corrected monetary base. To recall the conditions to avoid a change in the corrected monetary base, see equation (5) (in subchapter 3.2).
[65]$t_{ER} \downarrow \longrightarrow ER \uparrow \longrightarrow M^S = M \downarrow \longrightarrow D_{SAV} \downarrow \longrightarrow T_{SAV} \downarrow \longrightarrow C \downarrow \longrightarrow Y^D = Y \downarrow$

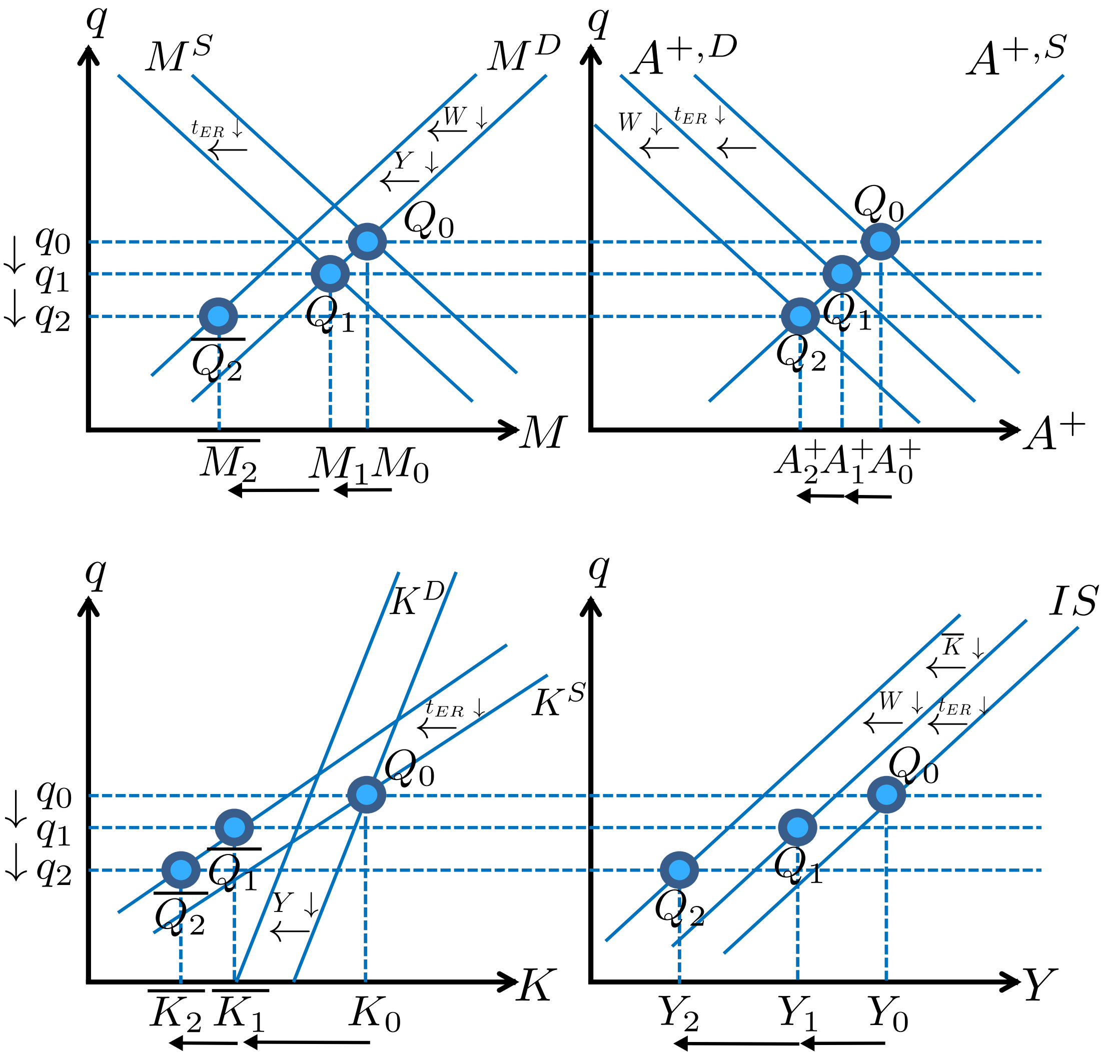


Figure 9: Reduction in the tax on excess reserves (four-markets model)

market converges to the equilibrium Q_1. At this point, the nominal value of real capital falls ($dP_{A^+}A^+ < 0$).
The tax cut creates an excess demand on the money market. The fall in q originating out of the market for real capital makes the money market converge towards the equilibrium point Q_1 (as discussed earlier, the equilibrium exists only under very specific conditions). The total amount of money in the system falls to M_1.
The credit market exhibits an excess demand. The fall in q makes the excess demand even wider (since K^D and K^S fall simultaneously). That leads to the rationing result at $\overline{Q_1}$. The shorter market side $\overline{K^S}$ at this point determines the amount of credit distributed in the market $\overline{K_1}$ ($dK < 0$).
In the case of the goods market, the respective fall in q and $\overline{K}$ lead to cuts in national income $dY < 0$ (Y_0 to Y_1).[66]

The secondary part shows the graphical path from Q_1 to Q_2. The wealth effect initiates the secondary part of the shock analysis ($dW < 0$), and the income effect ($dY < 0$) originates from the processes in the goods market of the primary part.
The decreasing wealth (due to the fall in real capital ($dP_{A^+}A^+ < 0$) leads to a left shift of $A^{+,D}$ (excess supply), M^D (excess supply), and Y^D (equilibrium).
The real capital market responds to its excess supply by a fall in q (q_1 to q_2), which leads to equilibrium point Q_2 on the market for real capital. The falling q leads to an even wider excess supply ($\overline{Q_2}$) on the money market. The credit market faces the fall in Y and reacts to it with a decrease in K^D, which creates a small excess demand in the credit market. The final amount of money is attained as q falls, and the credit market faces a greater excess demand. The overall amount of money falls (point $\overline{Q_2}$ is reached).
Finally, the goods market faces the fall in q and $\overline{K}$. Through the fall in Y, the income once again falls again ($dY < 0$), but the goods market stays in equilibrium. The fall in $\overline{K}$ arises because the credit market, which is already in rationing, faces a further tightening of its rationing result and makes the goods market shrink further. The fall in q decreases the income further until point Q_2 is reached (cf. figure 9).[67]
Generally, the effect of supply-side rationing, in this case, makes the income effect even stronger (positively or negatively) through $d\overline{K} < 0$. The reduction in tax on excess reserves ($dt_{ER} < 0$) makes only economic sense if the economy is overheating cyclically and the ICB is in need of cool down measures. This tax is like the penalty interest imposed on ER by the ECB in the European Monetary Union (Klose (2020)).

[66] In the case of high-income COs a reduction in I creates the reduction in Y. Through the fall in q, there is less incentive to invest in new to be produced real capital (equation (39)). In the case of low-income COs, the fall in the already rationed credit market makes new investment I more challenging (equation (36)).
[67] The fall in Y mainly is explained through equation (36) where a fall in q reduces C and I for high-income NBs and through equation (39) where a fall in q reduces I only.

It is very interesting to see how similar figure 9 ($dt_{ER} < 0$) is to figure 8 ($d\rho > 0$). The only differences (graphically) lie in the location parameters. The comparison with the three-markets model repeatedly reveals that the income effect and wealth effect have an accelerating effect on the four-markets model. In particular, this is clearly evident in the money, real capital and credit markets. The amplification affects both positively and negatively directed effects.

3.5.3 Analysis of the Remaining Shocks

Table 5 provides an overview of all the shocks that may hit the four-markets model. In the first column, all shocks are listed with positive and negative signs. In the first row of the table, all results corresponding to the shocks are observable. dq, dM, dA^+, dK and dY represent the changes in the respective endogenous variables. Expansive effects are marked with a plus (+), contractive effects are marked with a minus (−), and neutral effects are marked with zero (0). EQ_M, EQ_{A^+}, EQ_K, and EQ_Y stand for the equilibrium in the respective markets (money, real capital, credit, and goods market). The check-mark symbol (✓) stands for results in which an equilibrium is certain. In the real capital market, an equilibrium is attained by the reaction of Tobin's q. In the goods market, the equilibrium is attained by assuming that the goods supply can perfectly adjust to the demand for the goods. The cross mark symbol (X) stands for results, in which an equilibrium is possible, but highly unlikely. The money and credit market, by assumption, have no price mechanism (such as interest rates in the conventional banking system) that could bring the market into equilibrium.

The shocks S, t_{ER}, and B_m^x have different economic implications, but they are identical in terms of graphical results and direction of changes. A positive shock of them leads to expansive consequences for the economy. Since these shocks have been dealt with intensively subchapters 3.5.1 and 3.5.2, it is recommended consult them again if necessary.

The shocks ρ and t_{SAV} have the same implications for the economy but differ in the direction of the respective shock's impact. The fall in the joint risk parameter for the real capital and credit market and the rise in tax on savings accounts set a profound impulse to invest more in risky projects. It is an incentive to avoid risk-free options for capital preservation. Hence, the implications of these instruments for the economy are thorough. For a deeper insight into the effect of the risk parameter, it is advisable to go back to subchapter 3.5.1.

The consequences of the change in government yield parameter G differ greatly depending on its direction. The increase in G affects the goods market to grow, but in all other markets, including the price of real capital, Tobin's q stays constant[68]. Instead, the fall in G causes the goods, credit and money market to shrink. The market for real capital

[68] That only holds if $W = 0$, because the supply and demand in the real capital market is assumed to be independent of Y.

with its price Tobin's q remains constant.

Table 5: Overview of possible shocks in the four-markets model

Shocks	dq	dM	dA^+	dK	dY	EQ$_M$	EQ$_A$	EQ$_K$	EQ$_Y$
$dS > 0$	+	+	+	+	+	X	✓	X	✓
$dS < 0$	-	-	-	-	-	X	✓	X	✓
$dt_{ER} > 0$	+	+	+	+	+	X	✓	X	✓
$dt_{ER} < 0$	-	-	-	-	-	X	✓	X	✓
$dB^x_m > 0$	+	+	+	+	+	X	✓	X	✓
$dB^x_m < 0$	-	-	-	-	-	X	✓	X	✓
$d\rho > 0$	-	-	-	-	-	X	✓	X	✓
$d\rho < 0$	+	+	+	+	+	X	✓	X	✓
$dt_{SAV} > 0$	+	+	+	+	+	X	✓	X	✓
$dt_{SAV} < 0$	-	-	-	-	-	X	✓	X	✓
$dG > 0$	0	0	0	0	+	X	✓	X	✓
$dG < 0$	-	0	0	-	-	X	✓	X	✓

Comparing the results between tables 4 and 5 clarifies that the goods market becomes the amplifier of the shocks. It applies to both, positive and negative shocks. That is particularly evident in the credit market. In the three-markets model, the credit market has always reacted to shocks contrary to the other markets. It does not hold for the four-markets model. Another point that stands out in the comparison between the three-markets model and four-markets model has to do with the possibility of an equilibrium in the money market. In the three-markets model, equilibrium was possible under certain circumstances, but higher dynamic effects in the four-markets model, so equilibria seem to be hardly possible. The interdependencies between markets are more complex. These include the repercussions of wealth effects, tightened or defused credit rationing constellations, or the heterogeneous handling of the change in Tobin's q (concerning COs with high/low incomes).

It is also interesting to see how the heterogeneity of agents in the case of a crisis (an increase of the risk parameter $d\rho > 0$) leads to redistribution among non-banks with high and low income. That has not been studied in model theory applied to a potential Islamic financial system to the author's knowledge.

4 A New Keynesian Islamic Banking Model

The New Keynesian Macroeconomics (NKM) extends the traditional Keynesian theory. It applies general equilibrium theory and basic microeconomic principles to analyze external shocks, income growth, business cycles, fiscal policy, and monetary policy (cf. Gali (2015), Vitek (2017), and Walsh (2017)). NKM models, which stem from the class of dynamic stochastic general equilibrium (DSGE) models, contain nominal rigidities and monopolistic competition in the goods and factor market. The monetary policy is conducted by a simple Taylor-type interest rate rule (Taylor, 1993). A comprehensive introduction to New Keynesian theory is provided by Bofinger et al. (2006), Gali (2015), and Walsh (2017). In the following, a micro-foundation specified on the assumptions and preferences of Islamic banking will be derived. As interest rates are abolished in the framework at hand, an approach is needed in which a central bank can regulate the economy without a Taylor rule. Instead of following such an interest rate rule, the central bank is assumed to conduct monetary policy with the money supply. Major central banks tended towards zero interest rates or went even below predominantly in the developed world in the aftermath of the financial crisis 2007/2008.[69] The scope of interest rates seemed to be limited in the deflationary environment of the past decade. Hence, unconventional instruments, which directly or indirectly influence the money supply, became especially eminent in the course of the last decade's central bank policies. Hence, many attempts have emerged to extend the NKM model with an endogenous money market in recent times. Manea (2020) includes endogenous money creation into an NKM model over the private banking sector, leading to the exact equilibrium representation of the NKM model without an LM curve. The inside-money concept is an implicit banking level approach in order to introduce money into an NKM model. A much broader approach to develop an NKM model with money was undertaken by Piazzesi et al. (2019). They tried to modulate a banking system into an NKM model focused on inside money. Both Manea (2020) and Piazzesi et al. (2019) focused on the stake of the commercial banking system in money creation. Offick and Wohltmann (2014) present an NKM model with money and credit supply. In their framework, the central bank executes monetary policy via the monetary base and the refinancing rate and cannot directly influence the nominal interest rate. The model to be derived in the following will be closely attached to the work of Offick and Wohltmann (2014), integrating a money, and stock market from the three-markets model (similar to subsection 3.2) into the NKM model. The mechanics are shown in more detail in the following.

It is crucial to implement explicit money and credit markets into the NKM to attain a

[69]Recently, there has been a change in key interest rates, which are currently being raised by the Fed due to strong inflationary pressures and economic overheating tendencies, especially in the US. Obviously, this has a major signaling effect for the central banks around the world.

model that can display the fine but clear line between conventional and Islamic banking. As shown before, the main difference between the two systems lies in the preference for different forms of financing. The Islamic banking theory prefers modes of financing based on profit and loss sharing contracts. In contrast, the conventional banking theory prefers modes of financing based on debt-based contracts. Given this distinct feature, there is a need to develop a thoroughly microfounded model on the principle of sharing profits and losses. After deriving the New Keynesian Islamic banking model (NKIBM), various shocks will be analyzed in a static approximation of this model (short-term effects). Therefore, the long-term effects of shocks on the money, credit, and stock market will be studied in the dynamic NKIBM.

4.1 Model Derivation

The general New Keynesian Macroeconomics (NKM) is based on the following assumptions: profit-maximizing agents, intertemporal utility optimization, rational expectations, monopolistic competition, and staggered prices on the goods market. The closed baseline model refrains from capital, private investment, government expenditure, and net exports (Gali, 2015).

As in all previous models in this monograph, the markets will depart from a cleared/equilibrium initial state. All the assumptions mentioned above will be applied to the Islamic banking version of the model. The differences will stick out as the fundamental equations of the model are derived.

4.1.1 Money and Credit Demand

The optimization problem is solved by a representative household that operates under period utility function, a money-and-credit-in-the-utility approach with non-separable preferences. The household's lifetime utility is subjected to the period budget constraint:[70]

$$C_\tau + \frac{M_\tau}{P_\tau} + \frac{M_{\tau-1}t_{\tau-1}}{P_\tau} + \frac{A_\tau}{P_\tau} + \frac{K_{\tau-1}}{P_\tau} = \frac{w_\tau}{P_\tau}N_\tau + (1+e_{\tau-1})\frac{A_{\tau-1}}{P_\tau} + \frac{M_{\tau-1}}{P_\tau} + \frac{K_\tau}{P_\tau} \quad (57)$$

The budget constraint starts from the premise that the household has four options to generate income: holding cash M_τ, taking up a credit K_τ, investing in stocks A_τ, and supplying labor N_τ to the firm sector. In contrast to Offick and Wohltmann (2014), bond holdings for households are not possible. Instead, stocks can be held because the stock market can introduce the profit and loss sharing aspect (important to Islamic banking) into the model in a market-efficient way. The return on the stock market is the dividend yield e_τ[71] as it has been already defined in the Islamic version of the Keynesian model

[70]Note that τ denotes time, whereas t is tax rate as in the previous chapters.

[71]Recall the dividend yield from previous chapters which is defined as $e = \frac{\text{dividends per stock}}{\text{stock price}}$.

(three-markets model (subchapter 3.3)). Similarly, no interest rate is charged on credits. Cash, credits, and stocks are assumed to be held for one period. The difference to the Keynesian Islamic banking model is that there the household was able to choose between a saving deposit D_{SAV} and an investment deposit D_{INV}. The market was defined as cashless. In the New Keynesian version, cash and deposits are equal. There is no distinction between different forms of deposits, and there is no interest paid on deposits. An unavoidable tax on cash ensures that the household does not hoard high amounts of cash. The right-hand side of the budget constraint consists of the available funds that a household already possesses. The available funds originate out of labor income $w_\tau N_\tau$, dividend yield $(1+e_{\tau-1})A_{\tau-1}$, cash holding from the previous period $M_{\tau-1}$ and received credits K_τ. The left-hand side shows how the available funds are distributed by the household. These funds are spent on real consumption $P_\tau C_\tau$ at price P_τ, cash holding M_τ, the amount of tax that is levied on cash holding $M_{\tau-1}t_{\tau-1}$, stock investment A_τ and repayment of the credit amount $K_{\tau-1}$.
Considering the money-and-credit-in-the-utility[72] approach, the household is assumed to have non-separable preferences, as in the model by Offick and Wohltmann (2014, p. 258), which is considered:

$$U\left(C_\tau, \frac{M_\tau}{P_\tau}, \frac{K_\tau}{P_\tau}, N_\tau\right) = \frac{\Xi_\tau^{1-\sigma}}{1-\sigma} - \frac{N_\tau^{1+\eta}}{1+\eta} \tag{58}$$

where σ is the inverse of the elasticity of intertemporal substitution, η is the inverse of the Frisch elasticity of labor supply, and Ξ_τ represents the composite CES-index of consumption, real balances, and credits:

$$\Xi_\tau = \left[\alpha_1 C_\tau^{1-v} + \alpha_2 \left(\frac{M_\tau}{P_\tau}\right)^{1-v} + \alpha_3 \left(\frac{K_\tau}{P_\tau}\right)\right]^{\frac{1}{1-v}} \tag{59}$$

The inverse elasticity of substitution between the different components of Ξ_τ is given by v. $\alpha_1 > 0$, $\alpha_2 > 0$ and $\alpha_3 > 0$ are the relative weights, with which consumption, real balances and credits contribute to the household's period utility ($\alpha_1 + \alpha_2 + \alpha_3 = 1$).
Defining $\beta \in [0,1]$ as the discount factor and E as the expectation operator, the representative consumer maximizes lifetime utility:

$$E_0 \sum_{t=0}^{\infty} \beta^\tau U\left(C_\tau, \frac{M_\tau}{P_\tau}, \frac{K_\tau}{P_\tau}, N_\tau\right) \tag{60}$$

[72] The money-and-credit-in-the-utility approach is not the only way to construct a utility function. In the process of model derivation, many alternatives were discussed, including the so-called SINU (stock in non-separable utility) approach by Lengnick and Wohltmann (2016, p. 3) where shares/stocks (instead of money and credit) are explicitly considered in the utility function. The money-and-credit-in-the-utility approach prevailed because it allowed the greatest distinction between an Islamic and conventional NKM model.

with respect to the period-by-period budget constraint (57). The maximization is done by applying the Lagrangian approach. In A.6 of the appendix, it is observable that consumption C_τ, money M_τ, credit K_τ, and labor N_τ are essential for the utility of the household. Given these preferences, the household tries to maximize its budget. The following first-order conditions arise as the derivation of the Lagrangian function (with its shadow price λ_τ) regarding C_τ, A_τ, M_τ and K_τ is undertaken:

$$\frac{1}{1+e_\tau} = \beta E_\tau \left\{ \left(\frac{\Xi_{\tau+1}}{\Xi_\tau}\right)^{v-\sigma} \left(\frac{C_{\tau+1}}{C_\tau}\right)^{-v} \frac{1}{P_{\tau+1}} \right\} \qquad \text{(Euler equation)} \qquad (61)$$

$$\left(\frac{M_\tau}{P_\tau}\right)^{-v} = \frac{\alpha_1}{\alpha_2} C_\tau^{-v} \left(1 + \frac{1-t_\tau}{1+e_\tau}\right) \qquad \text{(real balances demand)} \qquad (62)$$

$$\left(\frac{K_\tau}{P_\tau}\right)^{-v} = \frac{\alpha_1}{\alpha_3} C_\tau^{-v} \left(\frac{e_\tau}{1+e_\tau}\right) \qquad \text{(credit demand)} \qquad (63)$$

The demand for real balances (62) is increasing in consumption C_τ, decreasing in the tax rate on cash t_τ and decreasing in return on stocks e_τ.[73]

The demand for credits (63) increases in consumption C_τ and decreases in return on stocks e_τ. The finding that e_τ has a negative relationship with the credit demand contrasts with the Keynesian credit demand (27), when a positive relationship holds. The Keynesian version of the model assumed that credit demand originates from the speculation motive, among other motives.[74]

For the whole mathematical derivation of the Euler, money demand, and credit demand function, see A.6 in the appendix.

The money and credit demand functions (62) and (63) form can be written in a log-linear form as:

$$m_\tau - p_\tau = c_\tau - \frac{1}{v} \cdot \left(\frac{1}{1-\bar{t}_0} \cdot (t_\tau - \bar{t}_0) + \frac{1}{1+\bar{e}_0}(e_\tau - \bar{e}_0) \right) \qquad (64)$$

$$k_\tau - p_\tau = c_\tau - \frac{\beta^2}{v(1-\beta)}(e_\tau - \bar{e}_0) \qquad (65)$$

where $\beta = \frac{1}{1+\bar{e}_0}$ and $\bar{e}_0 = \frac{1-\beta}{\beta}$.

The log-linearization of the money demand and credit demand function can be found in subsection A.7 in the appendix.

[73] This relationship is in line with the corresponding relationship function of the Keynesian money demand (26).

[74] The speculation motive with regard to the credit demand implies that as the dividend yield rises ($e_\tau \uparrow$), the agent demands more credit in order to utilize the higher return on the stock market.

4.1.2 Money and Credit Supply

In the following, the money and loan supply functions from the Keynesian version of the Islamic banking model (three-markets model) are taken from their initial form (cf. equations (16) and (18)), extended by the disturbance term ϵ_k, and converted to the log-linear form of the respective nominal equations as follows:

$$m = b_m^x + a_1 \cdot (e - \bar{e}_0) + a_2 \cdot (s - \bar{s}_0) + a_3 \cdot (t - \bar{t}_0) - a_4 \cdot (\rho - \bar{\rho}_0) - a_5 \cdot (\epsilon_K - \bar{\epsilon}_{K,0}) \tag{66}$$

$$k = b_m^x - r_1 \cdot (e - \bar{e}_0) + r_2 \cdot (s - \bar{s}_0) + r_3 \cdot (t - \bar{t}_0) - r_4 \cdot (\rho - \bar{\rho}_0) - r_5(\epsilon_K - \bar{\epsilon}_{K,0}) \tag{67}$$

where $m = \frac{dM}{\bar{M}_0}$, $k = \frac{dK}{\bar{K}_0}$ and $b_m^x = \frac{dB_m^x}{\bar{B}_{m,0}^x}$ are given as percentage deviations from their respective steady states ($\bar{M}_0 = \bar{m}_0^s \bar{B}_{m,0}^x$ and $\bar{K}_0 = \bar{k}_0^s \bar{B}_{m,0}^x$). The return on stocks (dividend yield) e, amount of credit from the central bank S , tax t[75], risk parameter ρ and credit shock parameter ϵ_k are expressed in absolute (not percentage) differences from their steady states ($\bar{e}_0$, $\bar{S}_0$, $\bar{t}_0$ and $\bar{\rho}_0$).[76] The coefficients a_i and r_i are *semi*-elasticities and are defined in the following: $a_1 = \frac{m_e^S}{\bar{m}_0^S}$, $a_2 = \frac{m_s^S}{\bar{m}_0^S}$, $a_3 = \frac{m_t^S}{\bar{m}_0^S}$, $a_4 = \frac{m_\rho^S}{\bar{m}_0^S}$, $r_1 = \frac{k_e^S}{\bar{k}_0^S}$, $r_2 = \frac{k_s^S}{\bar{k}_0^S}$ and $r_3 = \frac{k_t^S}{\bar{k}_0^S}$, $r_4 = \frac{k_\rho^S}{\bar{k}_0^S}$. The *semi*-elasticities a_5 and r_5 are built similarly: $a_5 = \frac{m_{\epsilon_K}^S}{\bar{m}_0^S}$ and $r_5 = \frac{k_{\epsilon_K}^S}{\bar{k}_0^S}$.

The method of inserting the explicitly Keynesian money and credit supply into a New Keynesian version of the model provides some options to undertake monetary policy with direct and indirect instruments of money control. This includes, in particular, the variables: monetary base b_m^x, amount of loans provided to commercial banks from the central bank s, and the tax t on cash. Ordinary conventional New Keynesian models solely rely on the Taylor rule. Since positive interest rates do not exist in the Islamic banking system, no classical Taylor Rule can be applied. Therefore, s and t are suitable alternative instruments for Islamic monetary policy authorities. Especially in the face of shock variables, such as the joint risk parameter of the credit and stock market ρ or the credit market shock ϵ_k.

The positive relationship between t and the money and credit supply functions is due to the assumption that an increase in t is expected to divert the capital of the households from money to credit and stocks. That, in turn, leads to positive effects on the money and credit supply since more capital is available for the open market. The method of inserting the explicitly Keynesian money and credit supply into a New Keynesian version of the model provides some options to undertake monetary policy with direct and indirect instruments of money control. This includes, in particular, the variables: monetary base b_m^x, amount of loans provided to commercial banks from the central bank s, and the tax

[75] In this model it is assumed that $t_{ER} = t_{SAV} = t$, because in the present model excess reserves ER are not explicitly formulated, meaning the differentiation between t_{ER} and t_{SAV} is not possible.

[76] Because the household does not have to choose between saving and investment accounts in the first place, the $\alpha(\cdot)$ coefficient has been taken out of the money and credit supply respectively.

on cash t. Ordinary conventional New Keynesian models solely rely on the Taylor rule, but s and t provide increased flexibility to intervene in the market.

4.1.3 IS Equation and Phillips Curve

In line with the log-linearized credit demand, the Euler consumption equation (61) can be expressed as:

$$c_\tau = E_\tau c_{\tau+1} - \frac{1}{\sigma}(e_\tau - E_\tau \pi_{\tau+1} - e_0) + \frac{v-\sigma}{\sigma}\{X_1 E_\tau \Delta e_{\tau+1} + X_2 E_\tau \Delta t_{\tau+1}\} \tag{68}$$

where $\Delta e_{\tau+1} = e_{\tau+1} - e_\tau$ and $\Delta t_{\tau+1} = t_{\tau+1} - t_\tau$. The coefficients X_1 and X_2 in the log-linearized Euler equation (68) are defined as follows:

$$X_1 = \frac{1}{\bar{\Xi}_0^{1-v}}\frac{1}{v}\left\{\alpha_3 \frac{\beta^2}{1-\beta}\left(\frac{\bar{K}_0}{\bar{P}_0}\right)^{1-v} + \alpha_2 \frac{1}{(1+\bar{e}_0)}\left(\frac{\bar{M}_0}{\bar{P}_0}\right)^{1-v}\right\} \tag{69}$$

$$X_2 = \frac{1}{\bar{\Xi}_0}^{1-v}\frac{1}{v}\alpha_2 \frac{1}{1-\bar{t}_0}\left(\frac{\bar{M}_0}{\bar{P}_0}\right)^{1-v} \tag{70}$$

v and σ are assumed to be unequal ($v \neq \sigma$), meaning that the consumption level c_τ depends besides future consumption ($E_\tau c_{\tau+1}$) and the real return on stocks ($e_\tau - E_\tau \pi_{\tau+1}$) also on expected changes of the stock return ($\Delta e_{\tau+1}$) and tax on cash ($\Delta t_{\tau+1}$). v stands for the semi-elasticity of the credit demand. From Offick and Wohltmann (2014) and Gali (2015) the assumption that $v \geq \sigma$ is taken. Additionally, X_1 and X_2 (by definition) are both positive.[77]

In contrast to the conventional money and credit in the utility approach by Offick and Wohltmann (2014), now the main variables to influence consumption C_τ are the stock return e and the tax on cash t (instead of the bond interest rate i_B and credit interest rate i_L).

The consumption function (68) will be transformed into an IS equation, so a comparison to the Keynesian version of the Islamic banking model (four-markets model) is worthwhile. In equation (56), the foundation for heterogeneity is laid. It is categorized as poor and rich non-banks (households and firms) with relatively direct consumption, investment, and reallocation of financial means.

An expected rise in the future stock return ($E_\tau e_{\tau+1} \uparrow$) decreases the future demand for real balances, credits and future marginal utility of consumption. Under considerations of intertemporal consumption smoothing this means that present consumption ($c_\tau \uparrow$) is preferred over future consumption ($U_{C\tau+1}\downarrow$).[78]

An expected rise in the future tax on cash ($E_\tau t_{\tau+1} \uparrow$) instead would lead to a decrease

[77] X_1 and X_2 have to be positive, because all the parameters (cf. Table 4) are greater than zero. This is in sharp contrast to Offick and Wohltmann (2014) where the expression behind X_1 contained a subtraction. As a result, the sign of this expression was unclear ($X_1 \lesseqgtr 0$).

[78] This holds if the log-linearized Euler equation fulfills the following assumptions: $v > \sigma$ and $X_1 > 0$.

in future real balances demand, decreasing $E_\tau X_{\tau+1}$ (for any given $E_\tau C_{\tau+1}$). The future marginal utility of consumption is expected to fall ($U_{C\tau+1}\downarrow$), leading to a rise in current consumption ($c_\tau \uparrow$). The explicit IS equation follows in equation (72).

The inflation rate π_τ evolves according to a forward-looking New Keynesian Phillips curve (cf. Gali (2015)):

$$\pi_\tau = \beta E_\tau \pi_{\tau+1} + \delta x_\tau + \epsilon_\tau \tag{71}$$

where the current inflation rate π_τ is driven by the expected inflation rate $E_\tau \pi_{\tau+1}$, the output gap x_τ (with $\delta > 0$), and the exogenous cost push shock ϵ_τ.

4.1.4 Differences to Conventional New Keynesian Models

Table 6: Model-based differences between Islamic banking and conventional banking in the context of New Keynesian models

	Islamic Banking	**Conventional Banking**
Equilibrium Prices	only price in the markets is dividend yield e	bond interest rate i_B, loan interest rate i_L and interest on excess reserves z
Securities	stock market A	bond market B
Equilibrium	the credit market without an equilibrium price results in rationing after shocks	all markets usually tend towards equilibrium
Interest Rate Management	no such element as no positive interest existent in the system	the central bank follows a standard Taylor rule
Taxation	wealth tax t (*zakat*) creates the negative interest rate in the system	no such element within baseline NKM model without government

Table 6 summarizes the most important model-based differences between Islamic banking and conventional banking in the context of New Keynesian models.

The main differences are:

First, there is only one price in the NKIBM, the dividend yield e compared to typically three prices in the NKM, lending rate i_L, borrowing rate i_B and interest rate on excess reserves z. Second, in the NKIBM, the bond market is replaced by the stock market. Third, equilibrium is not reached in the credit market in the NKIBM because there is no i_L as there is in the NKM. Therefore, there are inevitable rationing constellations in the credit market. Fourth, the NKIBM does not have a Taylor rule to guide interest rate policy. The exogenous wealth tax (*zakat*) ensures that a negative interest rate and thus a redistribution from high-income to low-income market participants is organized.

4.2 Static Approximation

After attaining all important equations, the complete model framework is formulated as a static approximation. The aim is to study the comparative-static effects of monetary and non-monetary shocks on the money, credit, and goods market. The equation system consists of differentiated equations. As elucidated before, the money and credit supply are taken from the Keynesian Islamic banking model (three-markets model).

4.2.1 Log-Linear Equations

A few assumptions have to be formulated to grasp the idea of the standard New Keynesian version of the model. The equilibrium condition $y = c$ holds (no private investment, no capital holdings, and no government spending). The parameter $c_1 = \frac{v-\sigma}{\sigma} X_1$ and $c_2 = \frac{v-\sigma}{\sigma} X_2$ are both assumed to be positive, due to the prior assumption of $v \geq \sigma$ and $X_1, X_2 > 0$. All other parameters (q_i, l_i and r_i) are also assumed to be positive. A static approximation of the dynamic Euler and Phillips curve equation is used. In this static version, no transitory dynamics are assumed, so changes in π are equivalent to changes in the price level ($d\pi = dp$ with $\pi = p - p_0$). The assumption (common to static approximations) that the output gap is equal to output ($dx = dy$) is applied. The respective shock parameters ϵ_y, ϵ_π, and ϵ_k have been added to the equations in an ad-hoc way.

The expected changes in the stock return and tax on cash are given by $\Delta e^e = e^e - e$ and $\Delta t^e = t^e - t$, where the expected future stock return rate e^e and expected tax on cash t^e are assumed to be exogenous.

The complete NKIBM in differentiated form with money and credit in the utility reads as follows:

$$dy = dy^e - b(de - d\pi^e) + c_1 d(\Delta e^e) + c_2 d(\Delta t^e) + d\epsilon_y \tag{72}$$

$$d\pi = \beta d\pi^e + \delta dy + d\epsilon_\pi \tag{73}$$

$$dm^D - dp = q_1 dy - q_2 de - q_3 dt \tag{74}$$

$$dm^S = db_m^x + a_1 de + a_2 ds + a_3 dt - a_4 d\rho - a_5 d\epsilon_k \tag{75}$$

$$dk^D - dp = l_1 dy - l_2 de \tag{76}$$

$$dk^S = db_m^x - r_1 de + r_2 ds + r_3 dt - r_4 d\rho - r_5 d\epsilon_k \tag{77}$$

$$dp = d\pi \tag{78}$$

$$dm^r = dm - dp \tag{79}$$

$$dk^S \neq dk^D \tag{80}$$

The equations representing the goods, money, and credit market must be read in pairs. Equations (72) and (73) stand for the goods market (IS derived from (68) and Phillips

curve derived from (71)). Compared to the conventional model, the IS curve (72) here does not depend on interest rates, instead on the dividend yield e. In contrast to the four-markets model from chapter 3.4, heterogeneity was even introduced to formalize the redistribution mechanism, which is not existent in the NKIBM. The equations (74) and (75) represent the money market (money demand (derived from (66)) and supply (derived from (58)). The tax t is particularly important in connection with the moeny demand (74), because by definition taxes in NKIBM are supposed to prevent hoarding cash in difficult economic situations. However, it is defined exogenous. The equations (76) and (77) constitute credit market (credit demand derived from (67)) and supply (derived from (59)). In the credit market, there are no interest rates at all, hence no price to bring it to equilibrium. In general, the credit market will also induce rationing as in the four-markets model. In particular, the tax t is beneficial for the credit supply (77), because as it increases, the incentive to lend increases also.
In this model, it is assumed, in contrast to previous models, that the money market is in equilibrium.[79] The graphical and algebraic analysis in the three-markets and four-markets model have shown that equilibrium in the money market is achievable. In the NKIBM, the dividend yield e brings (besides the stock market) the money market into equilibrium. The dividend yield here plays the same role as the interest rate in the conventional approach by Offick and Wohltmann (2014). The interest rate brings money and bond market into equilibrium (law of one price). Similarly, the dividend yield e (brings in NKIBM) money and stock market into equilibrium. The stock market behaves inversely to the money market in the NKIBM. The credit market is also expected to exhibit rationing results, and because of this, the demand and supply sides are supposed to be unequal ($dk^S \neq dk^D$).

4.2.2 Calibration

The model was calibrated and parametrized quite similarly to the model formulated by Offick and Wohltmann (2014) in order to have a good comparability of results despite the inherent model-based differences.
The discount factor β is set to 0.99, the Calvo (which is defined as the degree of price stickiness) parameter Ω is 0.75, the inverse elasticity of intertemporal substitution σ is 2, the inverse of the Frisch elasticity of labor supply η is 2 and the inverse of the elasticity of intratemporal substitution v is 25. The different (semi-)elasticities of money supply are defined as a_i (return on stocks $a_1 = 3.9$, loan from the Islamic central bank $a_2 = 1$, tax rate elasticity $a_3 = 0.25$, joint risk rate for the credit and stock market $a_4 = 0.9$ and credit shock coefficient $a_5 = 0.9$). The different (semi-)elasticities of credit supply are

[79] This is a very harsh assumption, however, in the Keynesian Islamic banking model, the possibility of the money market ending up in equilibrium was discussed in the context of the three-markets model and four-markets model in detail.

defined as r_i (return on stocks $r_1 = 4.04$, loan from the Islamic central bank $r_2 = 1$, tax rate elasticity $r_3 = 0.9$, joint risk rate for the credit and stock market $r_4 = 1$ and credit shock coefficient $r_5 = 1$).
The slope of the Phillips curve δ is assumed to be 0.34, the steady state return on stocks rate $\bar{e}_0$ is 0.01, the steady state tax on cash rate $\bar{t}_0$ is 0.02. The semi-elasticities of goods demand are defined as c_i (expected return on stocks $c_1 = 0.003$ and expected tax rate $c_2 = 0.46$). The semi-elasticities of money demand are defined as q_i (output $q_1 = 1$, return on stocks $q_2 = 4.04$ and tax rate $q_3 = 0.25$). The semi-elasticities of credit demand are defined as l_i (output $l_1 = 1$ and return on stocks $l_2 = 4.04$).
The individuals in the static approximation of the New Keynesian Islamic banking model (NKIBM) assume the formation of rational expectations (E_τ^R), which means that the individuals are model consistent and base their decisions on a complete information set (I_τ) in a deterministic world and build their expectations forward-looking.

$$E_\tau^R\left[y_{\tau+1}\right] = E_\tau\left[y_{\tau+1}\right] = E_\tau\left[y_{\tau+1}|I_\tau\right] \tag{81}$$

$$E_\tau^R\left[\pi_{\tau+1}\right] = E_\tau\left[\pi_{\tau+1}\right] = E_\tau\left[\pi_{\tau+1}|I_\tau\right] \tag{82}$$

$$E_\tau^R\left[e_{\tau+1}\right] = E_\tau\left[e_{\tau+1}\right] = E_\tau\left[e_{\tau+1}|I_\tau\right] \tag{83}$$

$$E_\tau^R\left[t_{\tau+1}\right] = E_\tau\left[t_{\tau+1}\right] = E_\tau\left[t_{\tau+1}|I_\tau\right] \tag{84}$$

4.2.3 Simulated Responses for the Static Model

The model's setup is close to that of Offick and Wohltmann (2014) in order to have a relatively good comparison with a conventional money and credit in the utility model. In the first step, the calibrated parameters are presented in Table 7.
The major differences between the conventional NKM developed by Offick and Wohltmann (2014) and the NKIBM are listed in table 6 and elucidated in subchapter 4.1.4.
At this point it makes sense to compare the results of the NKIBM shown in Table 8 on the one hand with the Keynesian Islamic four-markets model derived and analyzed in subchapters 3.4 and 3.5. (NKIBM and four-markets model both have goods market). And on the other hand, one can compare the results (from Table 8) with the results of the model developed by Offick and Wohltmann (2014). The shock responses of the model without the additional transmission effects (on the real economy) through e^e and t^e ($c_1 = c_2 = 0$) are shown in brackets.

There is a set of differences in comparison to the four-markets model, but the most obvious are:[80]
First, in the NKIBM, the vital price is dividend yield e, and in the four-markets model, it is Tobin's q. Second, the money market in the NKIBM is assumed to be in

[80]In order to grasp the main differences look up chapter 3.4.

equilibrium. Third, the tax in the four-markets model was twofold (on savings and excess reserves), which had a profound effect on diverting capital from savings accounts towards investment (credits and stocks). Fourth, second-round effects, such as the wealth effect and the repercussions from the credit and goods market, are also not included in the NKIBM. Fifth, the IS equation in the four-markets model encompasses a broader range of shocks, such as t, b_m^x, and ρ. Sixth, the credit demand function negatively correlates with the dividend yield e. The assumption that credits are used to speculate on the stock market (as in the four-markets model) is dropped in the NKIBM. Seventh, in the four-markets model, there is no price level included. Hence, inflationary effects cannot be analyzed.

The results in Table 8 confirm the results of the four-markets model in Table 5 regarding the sign of multipliers in the case of $db_m^x = 1$ (demand-side rationing on the credit market) and $d\rho = 1$ (supply sided rationing on the credit market). As assumed in the qualitative analysis in subsection 3.5.1, the results of Table 8 also conclude that a simultaneous $db_m^x = d\rho = 1$ shock would probably neutralize the positive effects of $db_m^x = 1$. On the contrary, the main difference between the respective results of the NKIBM and four-markets model lies in the tax shock ($dt = 1$ and $dt = -1$). In the NKIBM, a decrease in tax on cash leads overall to positive effects on output, inflation, return on stocks, and money. The results of the four-markets model differ according to the change in t in the response of the money and goods markets (dm and dy). The decrease in t leads to decreasing output and decreasing money demand and supply. The output and price effect is positive in the case of $c_1, c_2 > 0$. In the case of $c_1 = c_2 = 0$ the effect is negative.[81] In the four-markets model, the results of a decrease in taxes have similar effects as in the case of $c_1 = c_2 = 0$.

The NKM model proposed by Offick and Wohltmann (2014) and the NKIBM also have some major differences, which account for different outcomes:[82] First, the final results on the credit market (NKIBM: rationing, NKM: equilibrium). Second, the market prices (NKIBM: e, NKM: i_B, i_L and z). Ignoring the equilibrium of the credit market and the magnitude of the values leads to the result that the shocks $db_m^x = 1$ and $d\epsilon_k = 1$ are identical concerning their signs in both models (NKIBM and NKM). The shocks $d\pi^T = 1$[83], $d\epsilon_y = 1$ and the simultaneous shock of $db_m^x = d\epsilon_k = 1$ have more substantial differences in the direction of effects.

[81] The tax on cash t is the only shock that reacts substantially to $c_1 = c_2 = 0$ (see Table 8). In Offick and Wohltmann (2014), instead, $c_1 = c_2 = 0$ tends to dampen most results in their numerical magnitude. In case of the simultaneous shocks $db_m^x = d\rho = 1$ and $db_m^x = d\epsilon_K = 1$ the neutralizing effects are due to the assumption $a_5 = r_5 = 1$ ($a_4 = r_4 = 1$ respectively).

[82] For the following analysis, compare the results to Table 2 from Offick and Wohltmann (2014).

[83] π^T is the target level of inflation set by the CB, which is assumed to have the credibility of all market participants ($\pi^T = \pi^e$).

Table 7: Parameter calibration

Parameters	Value	Description
β	0.99	Discount factor
Ω	0.75	Calvo parameter
σ	2	Inverse of the elasticity of intertemporal substitution
η	2	Inverse of the Frisch elasticity of labor supply
v	25	Inverse of the elasticity of intratemporal substitution
α_1	0.95	Utility weight on consumption
α_2	0.04	Utility weight on real balances
α_3	0.01	Utility weight on credits
a_1	3.9	Return on stocks semi-elasticity of money supply
a_2	1	Loan from the ICB semi-elasticity of money supply
a_3	0.25	Tax rate elasticity of money supply
a_4	1	Risk rate semi-elasticity of money supply
a_5	1	Credit-shock coefficient semi-elasticity of money supply
r_1	4.04	Return on stocks semi-elasticity of credit supply
r_2	1	Loan from the ICB semi-elasticity of credit supply
r_3	0.9	Tax rate elasticity of credit supply
r_4	1	Risk rate coefficient semi-elasticity of credit supply
r_5	1	Credit-shock coefficient semi-elasticity of credit supply
δ	0.3433	Slope of the Phillips curve
$\bar{e}_0$	0.01	Steady state return on stocks rate
$\bar{t}_0$	0.02	Steady state tax on cash rate
c_1	0.003	Expected return on stocks semi-elasticity of goods demand
c_2	0.46	Expected tax rate semi-elasticity of goods demand
q_1	1	Output semi-elasticity of money demand
q_2	4.04	Return on stocks semi-elasticity of money demand
q_3	0.25	Tax rate semi-elasticity of money demand
l_1	1	Output semi-elasticity of credit demand
l_2	4.04	Return on stocks semi-elasticity of credit demand

Table 8: Numerical simulations of the static model

	dy	$d\pi$	de	dm^S	$d(m^D - p)$	dk^S	dk^D
$d\epsilon_y = 1$	0.92 (0.92)	0.32 (0.32)	0.16 (0.16)	0.61 (0.61)	0.29 (0.29)	-0.63 (-0.63)	0.61 (0.61)
$d\epsilon_\pi = 1$	-0.06 (-0.06)	0.98 (0.98)	0.12 (0.12)	0.45 (0.45)	-0.53 (-0.53)	-0.47 (-0.47)	0.45 (0.45)
$d\epsilon_k = 1$	-0.06 (-0.06)	-0.02 (-0.02)	0.12 (0.12)	-0.55 (-0.55)	-0.53 (-0.53)	-1.47 (-1.47)	-0.55 (-0.55)
$d\pi^T = 1$	0.40 (0.40)	1.13 (1.13)	0.19 (0.19)	0.75 (0.75)	-0.38 (-0.38)	-0.78 (-0.78)	0.75 (0.75)
$db_m^x = 1$	0.06 (0.06)	0.02 (0.02)	-0.12 (-0.12)	0.55 (0.55)	0.53 (0.53)	1.47 (1.47)	0.55 (0.55)
$dt = 1$	-0.39 (0.03)	-0.13 (0.01)	-0.13 (-0.06)	-0.25 (-0.02)	-0.12 (0.01)	1.44 (1.13)	0 (0.27)
$dt = -1$	0.39 (-0.03)	0.13 (-0.10)	0.12 (0.06)	0.25 (0.02)	0.12 (-0.01)	-1.44 (-1.13)	0 (-0.27)
$d\rho = 1$	-0.06 (-0.06)	-0.02 (-0.02)	0.12 (0.12)	-0.55 (-0.55)	-0.53 (-0.53)	-1.47 (-1.47)	-0.55 (-0.55)
$db_m^x = d\rho = 1$	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
$db_m^x = d\epsilon_K = 1$	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Note: The values in brackets represent the output that is attained by setting $c_1 = c_2 = 0$. Some minor inconsistencies appear in the table due to rounding.

4.3 Dynamic Model

In this subsection, the simulation of a dynamic version of the NKIBM is undertaken in the present subchapter to see the longer-term shock responses, which contrasts strongly with the short-term view of the static approximation of the NKIBM. Besides the standard assumption of rational expectation formation, boundedly rational expectations are also considered as a shortcut to implement backward-looking behavior into the NKIBM and thus generate (realistic) hump-shaped response functions. In the analysis of the static approximation, every shock resulted in disequilibrium in the credit market. Hence, the question arises whether it is possible that the credit market in a dynamic setting i.e. considering a longer time horizon may eventually end up in an equilibrium.

4.3.1 Log-Linear Equations

The following equations are formed from the basis of the static model (derived through the explicit micro-foundations in section 4.1):

$$y_\tau = \tilde{E}_\tau y_{\tau+1} - b(e_\tau - \tilde{E}_\tau \pi_{\tau+1}) + c_1(\tilde{E}_\tau \Delta e_{\tau+1}) + c_2(\tilde{E}_\tau \Delta t_{\tau+1}) + \epsilon^y_\tau \tag{85}$$

$$\pi_\tau = \beta \tilde{E}_\tau \pi_{\tau+1} + \delta y_\tau + \epsilon^\pi_\tau \tag{86}$$

$$m^D_\tau - p_\tau = q_1 y_\tau - q_2 e_\tau - q_3 t_\tau \tag{87}$$

$$m^S_\tau = b^m_\tau + a_1 e_\tau + a_2 s_\tau + a_3 t_\tau - a_4 \rho_\tau - a_5 \epsilon^k_\tau \tag{88}$$

$$k^D_\tau - p_\tau = l_1 y_\tau - l_2 e_\tau \tag{89}$$

$$k^S_\tau = b^m_\tau - r_1 e_\tau + r_2 s_\tau + r_3 t_\tau - r_4 \rho_\tau - r_5 \epsilon^k_\tau \tag{90}$$

$$\pi_\tau = p_\tau - p_{\tau-1} \tag{91}$$

The equations (85)[84] and (86)[85] represent the goods market, equations (87)[86] and (88)[87] represent the money market and (89)[88] and (90)[89] the credit market. As the dynamic version of the model considers more than two periods the inflation (91) is defined depending on past values of price level $p_{\tau-1}$. Those variables, which are forward-looking are now denoted with the time parameter $\tau + 1$. The growth in future return on stocks e and the tax on cash t have to be defined the following way: $\tilde{E}_\tau \Delta e_{\tau+1} = \tilde{E}_\tau e_{\tau+1} - e_\tau$ and $\tilde{E}_\tau \Delta t_{\tau+1} = \tilde{E}_\tau t_{\tau+1} - t_\tau$. The PC curve depends on the output gap x. In the static approximation of the model $dx = dy$ was assumed. Now in the dynamic model, recall the definition of the output gap $x_\tau = y_\tau - y^*_\tau$ where y^* is the potential output. As y^* is equal to zero, it is permissible to set $x_\tau = y_\tau$.

[84] The IS equation is derived from (68).
[85] The PC equation is derived from (71).
[86] The money demand equation is derived from (66).
[87] The money supply equation is derived from (58).
[88] The credit demand equation is derived from (67).
[89] The money supply equation is derived from (59).

The shock parameters ϵ_τ^y, ϵ_τ^π and ϵ_τ^k do not originate from micro-foundations, but instead were added ad-hoc to the respective functions.
Generally all shocks (t_τ, ρ_τ, s_τ, b_τ^m,ϵ_τ^y, ϵ_τ^π and ϵ_τ^k) are taking structurally the same form as e.g. the demand shock (ϵ_τ^y), which can be formulated as an AR(1)-process:

$$\epsilon_\tau^y = \varphi \epsilon_{\tau-1}^y + \eta_\tau^y \tag{92}$$

where η_τ^y is normally distributed:

$$\eta_\tau^y \sim \mathcal{N}(0,\, \sigma_y) \tag{93}$$

The autocorrelation coefficient φ is set to 0.8 for all shocks and the standard error is $\sigma_y = 1$ in $\tau = 0$.

4.3.2 Expectation Formation

In addition to rational expectations

$$E_\tau^R\left[y_{\tau+1}\right] = E_\tau\left[y_{\tau+1}\right] = E_\tau\left[y_{\tau+1}\middle|\, I_\tau\right] \tag{94}$$
$$E_\tau^R\left[\pi_{\tau+1}\right] = E_\tau\left[\pi_{\tau+1}\right] = E_\tau\left[\pi_{\tau+1}\middle|\, I_\tau\right] \tag{95}$$
$$E_\tau^R\left[e_{\tau+1}\right] = E_\tau\left[e_{\tau+1}\right] = E_\tau\left[e_{\tau+1}\middle|\, I_\tau\right] \tag{96}$$
$$E_\tau^R\left[t_{\tau+1}\right] = E_\tau\left[t_{\tau+1}\right] = E_\tau\left[t_{\tau+1}\middle|\, I_\tau\right] \tag{97}$$

with I_τ denoting the information set available to rational agents. Additionally, boundedly rational expectations are assumed for a share of agents. Individuals with rational expectations are model consistent and build their expectations forward-looking. In contrast, boundedly rational agents are assumed to have a limited understanding of the complex world and therefore rely on simple backward-looking heuristics. Di Bartolomeo et al. (2016) give a comprehensive overview of the potential of utilizing this approach fully for the case of an NKM model. The following equations will follow their notations closely:

$$E_\tau^{BR}\left[y_{\tau+1}\right] = \vartheta y_{\tau-1} \tag{98}$$
$$E_\tau^{BR}\left[\pi_{\tau+1}\right] = \vartheta \pi_{\tau-1} \tag{99}$$
$$E_\tau^{BR}\left[e_{\tau+1}\right] = \vartheta e_{\tau-1} \tag{100}$$
$$E_\tau^{BR}\left[t_{\tau+1}\right] = \vartheta t_{\tau-1} \tag{101}$$

BR stands for bounded rationality and the ϑ[90] is an adaption parameter. Its value reveals the underlying behavior of the representative agent. Di Bartolomeo et al. (2016) work with three forms of agents with boundedly rational expectations: adaptive, naive (static),

[90]Di Bartolomeo et al. (2016) use ϑ^2. Now use ϑ instead.

and extrapolative. Furthermore, agents with stationary expectations as e.g. in De Grauwe (2011) or Lengnick and Wohltmann (2016) are considered. The parameter ϑ in (98)-(101) determines the form of boundedly rational behavior as follows:

$$\text{stationary expectations:} \quad \vartheta = 0 \tag{102}$$

$$\text{adaptive expectations:} \quad 0 < \vartheta < 1 \tag{103}$$

$$\text{naive expectations:} \quad \vartheta = 1 \tag{104}$$

$$\text{extrapolative expectations:} \quad \vartheta > 1 \tag{105}$$

The stationary expectation formation $\vartheta = 0$ implies that the agents expect the inflation rate to return to the inflation target ($\pi^* = 0$) announced by the central bank. Similarly, these agents expect the output y_τ, stock return e_τ, and tax rate t_τ to return to their respective steady-state values ($\bar{y} = \bar{e} = \bar{t} = 0$).
The adaptive expectation formation ($0 < \vartheta < 1$) involves a learning process and is based on the observed value of the past, which the agents attempt to correct by the factor ϑ.
An agent with static (naive) expectations ($\vartheta = 1$) expects that future values of π_τ, y_τ, e_τ, and t_τ exactly correspond to the observed values of the previous period.
In the case of extrapolative expectation ($\vartheta > 1$) agents expect a disproportionate continuation of the observed trend.
It is assumed that rational and boundedly rational agents exist simultaneously in this economy. For instance for $y_{\tau+1}$ the following linear combination is formalized:

$$\tilde{E}_\tau y_{\tau+1} = \alpha E_\tau^R \left[y_{\tau+1}\right] + (1-\alpha) E_\tau^{BR} \left[y_{\tau+1}\right] \tag{106}$$

where α is defined in the interval between 0 and 1. Accordingly, α is the fixed fraction of rational agents, and $(1-\alpha)$ is consequently the fraction of boundedly rational agents.[91]

[91] No switching dynamics are assumed regarding the different types of agents.

4.3.3 Simulated Responses for the Dynamic Model

Now the dynamic model's impulse response functions (IRFs) to shocks[92] (cf. graphs 10-13) will follow. The calibrated parameters for the simulation of static approximation listed in Table 7 will still hold in the dynamic model. In the static NKIBM, the economy consisted of rational agents only. In the following, the economy is analyzed for two cases: (i) an economy consisting of rational agents ($\alpha = 1$) and (ii) an economy that has a mix of rational and boundedly rational agents ($\alpha = 0.65$). The first shock that will be analyzed is the monetary policy shock ($b_\tau^m \uparrow$). The analysis will be twofold: First, the IRFs of the rational agent version ($\alpha = 1$) of the model will be compared with the IRFs of Offick and Wohltmann (2014)[93], because their model also consists exclusively of rational agents. Second, the IRF of the rational version (which can be found in graph 10). will be compared with the mixed (rational and boundedly rational) version[94] ($\alpha = 0.65$) of the dynamic NKIBM. The consequences of the increase in b_τ^m on the dynamic NKIBM model (see graph 10) and the dynamic NKM model by Offick and Wohltmann (2014) are equal in the direction of effects (temporary rise in y, π, m, and k) but differ in the intensity/numerical magnitude. The dynamic NKIBM model has higher initial jumps, the effects of the shocks are more persistent,[95] the way back to the steady-state is more volatile, and the credit market exhibits an excess supply.[96] An interesting commonality between both IRFs is that there is an undershooting after the initial (positive) jump in the case of output and inflation. Then both lines tend towards a steady state. The increased volatility in y and π on the way to steady-state seem to have a connection with the transition from interest rate to money supply management (NKIBM and NKM model of Offick and Wohltmann (2014)). Moving from interest rate control (TR) to money growth rate control (b_m^x) generates increased persistence.

Now a mix of bounded rational ($(1 - \alpha) = 0.35$) and rational expectation formation ($\alpha = 0.65$) is considered. In the IRF of graph 11, this means that in each case, the boundedly rational agents take the form of four expectation formations (cf. equations (98) to (101)) with their respective ϑ values. For the following analysis of a rise in b_τ^m, the distinction is made between $\vartheta = 0$[97] and $\vartheta > 0$[98]. The initial jumps for the mixed version are equal/lower than in the rational version if $\vartheta = 0$. The initial jumps are equal/higher if $\vartheta > 0$ is considered. The persistence of shocks in case of y,π, and e is higher in the mixed version if $\vartheta > 0$ holds, and it becomes lower if $\vartheta = 0$ holds. The persistence of

[92] AR(1) process like in (92)
[93] Cf. figure 2 in Offick and Wohltmann (2014).
[94] cf. graph 11
[95] They need more time to return to their steady-state value.
[96] Until the credit demand and supply reach their steady-state values.
[97] Where stationary (exogenous) expectations are in place, and the dynamics in the model are limited.
[98] Where adaptive, naive and extrapolative expectation formation is present.

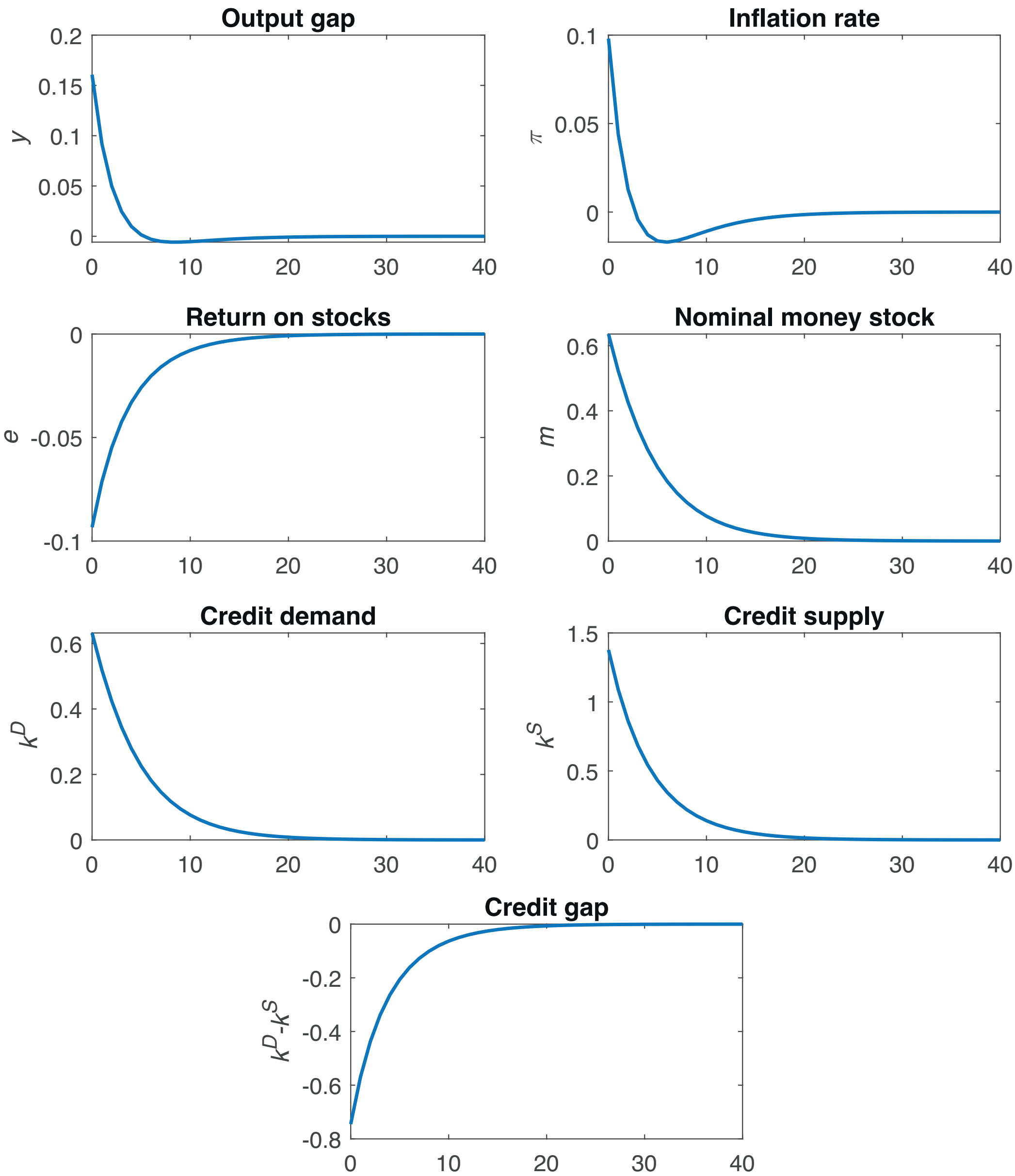


Figure 10: Responses to a shock process in of b_m^x (rational expectation formation $\alpha = 1$)

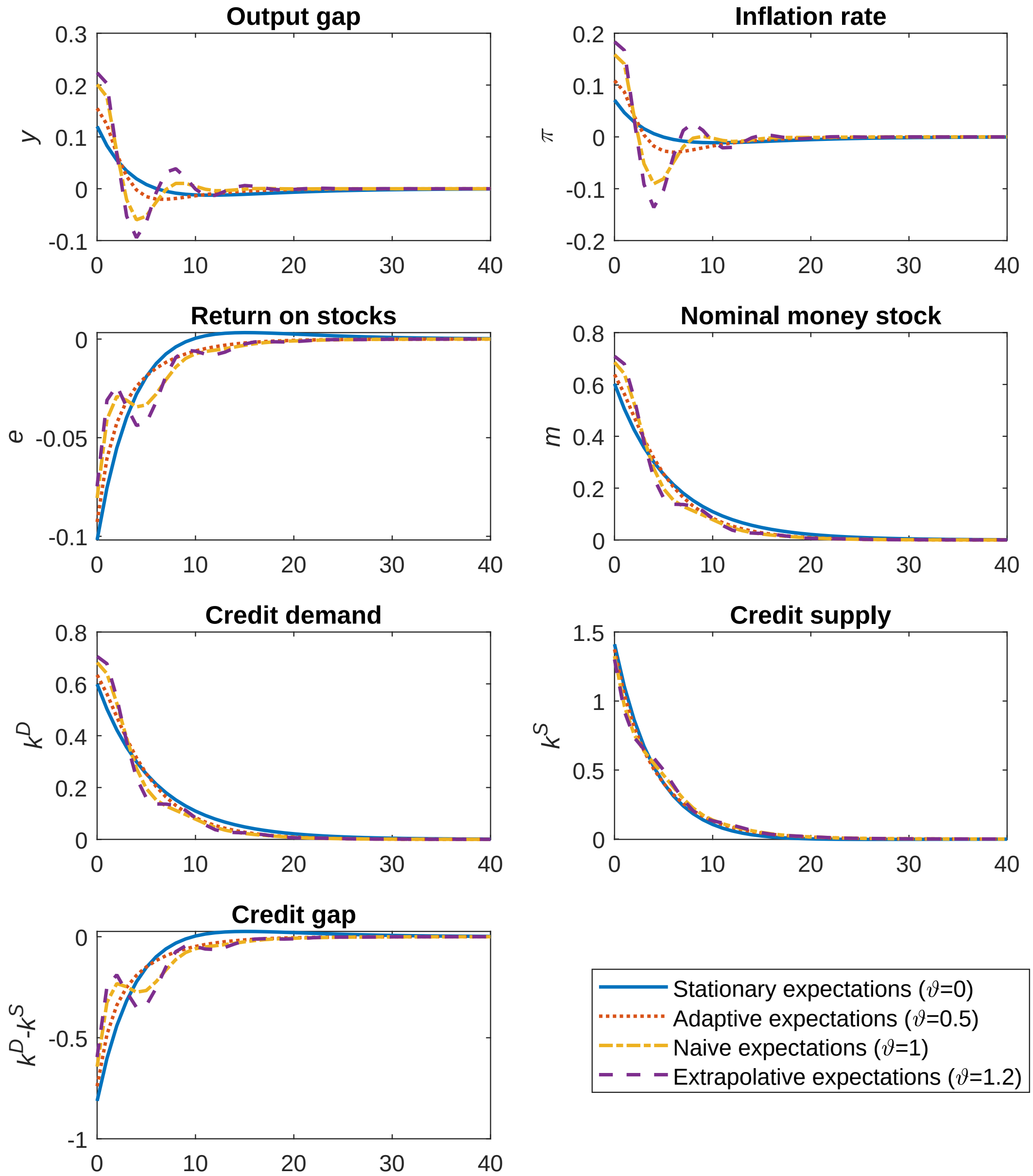


Figure 11: Responses to a shock process in of b_m^x (mixed expectation formation $\alpha = 0.65$)

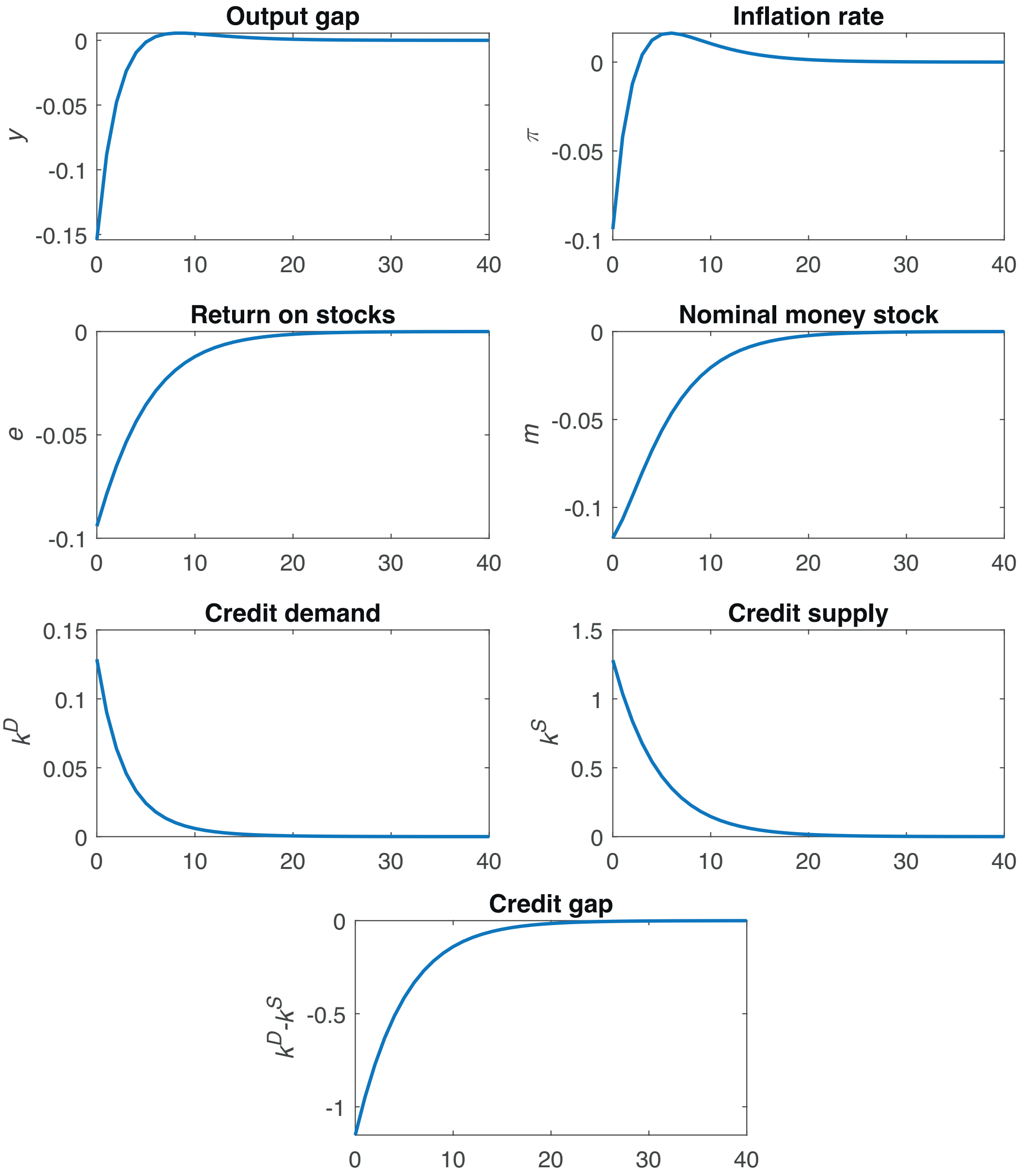


Figure 12: Responses to a shock process in of t (rational expectation formation $\alpha = 1$)

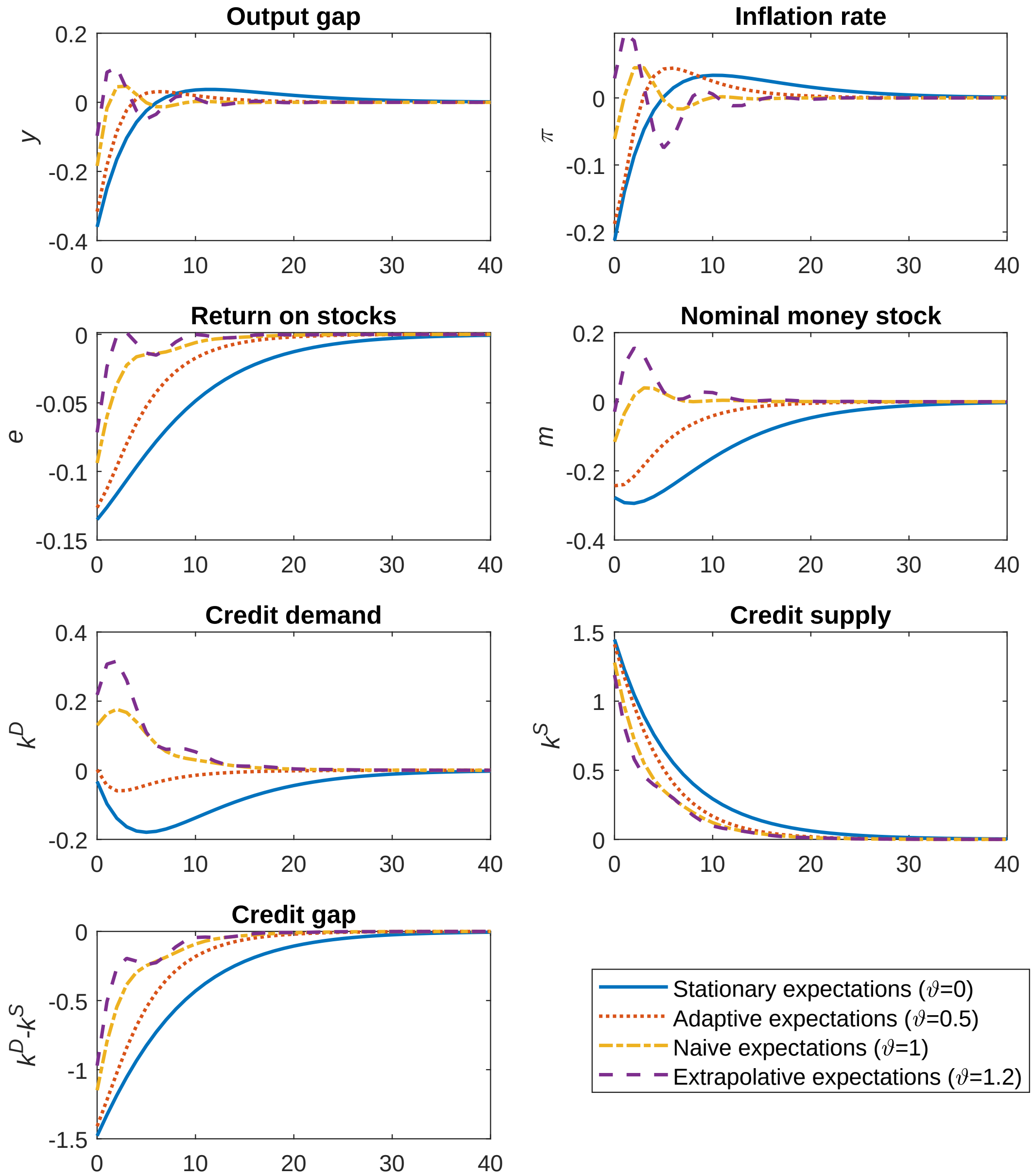


Figure 13: Responses to a shock process in of t (mixed expectation formation $\alpha = 0.65$)

shocks is lower in the mixed version for m and k in any case ($\vartheta \geq 0$). The volatility in the mixed version of the model is higher than in the rational version (except for the $\vartheta = 0$ case). Especially in the case of $\vartheta > 0$, hump-shaped behavior is observable (in particular if $\vartheta > 1$). Furthermore, there is a remarkable result in the credit gap ($k^D - k^S$) as the focus is on $\vartheta = 0$. After the initial jump, there is an interesting development between period 10 and 20, in which the credit gap changes its sign, and an excess demand instead of an excess supply appears on the credit market. This result is quite striking, since in the static model of the NKIBM, the change in sign and consequently the change in excess quantities was not visible.

The second shock is an increase in the tax on cash ($t \uparrow$). A comparison between the IRFs of the rational (see graph 12) and mixed version (see graph 13) of the NKIBM has to be undertaken.[99]
As it has been elucidated in the static version of the NKIBM, the tax t in the New Keynesian version has a different role than the comparable tax on savings account (t_{SAV}) Keynesian version (four-markets model). For a comparison one has to consider table 5 and figure 12. In both models a rise in taxes is analyzed. A rise of the tax on cash t in the NKIBM (contractive) has opposite effects than a rise of the tax on saving accounts t_{SAV} in the Keynesian model (expansive). In the NKIBM the effect is negative, because as the tax is levied as an exogenous variable the amount collected is out of the system. But in case of the four-markets model the tax is not only endogenously defined, it has greater expansive pushes in the case of money and goods market. In particular, the money market is considered as cleard (in equilibrium) in the NKIBM for simplicity, whereas equilibrium is hardly conceivable (for the money market) in the four-markets model. Hence, the divergence between supply and demand is intensified by the income and wealth effect, which arise in the secondary effect.
The initial drop in the IRF is more significant for y, π, and e in the boundedly rational version of the NKIBM. Thereby the declines are more intensive in the case of $\vartheta = 0$ than in $\vartheta > 0$. The initial jumps are relatively equal in all cases (E^R; E^{BR}: $\vartheta \geq 0$) on the money and credit market (m and c). The different variables exhibit equal/higher volatility for the boundedly rational version than the rational one. Thereby $\vartheta > 0$ has the highest degree of volatility. The persistence of shocks is also higher in the boundedly rational version. $\vartheta = 0$ stands out with the highest persistence. It is worth focusing on the return on stocks e because as naive or extrapolative expectation formation ($\vartheta \geq 1$) is assumed, the sign of the change in e even changes in the course. Boundedly rational ($1 > \vartheta \geq 0$) and rational versions imply substantial drops in e. That result is only observable in a dynamic version of the model.

[99] A comparison to the IRFs of the Offick and Wohltmann is not possible because in their model there is no such tax.

5 Conclusion

The thesis first and foremost provides a basic understanding of Islamic banking (Chapter 2). Most of the verbal descriptions in Islamic banking literature overemphasize Arabic terms, making it relatively complicated for Non-Arabic readers to familiarize themselves with the basic principles. In order to obtain a vital understanding of the differences between the two systems (Islamic and conventional), a specially calculated money-credit-stock-market-model (Chapter 3) was developed (later: money-credit-real-capital-market-model). This model exhibits the main differences between the conventional and the here derived "idealized" form of an Islamic banking system.[100] A summary of the main differences between Islamic and conventional banking systems is divided into two parts. In the first part, according to Table 1 (cf. subchapter 2.6), the differences are described on the level of principles. In the second part, according to Table 3 (see chapter 4), the differences are described on the model assumption level.

The differences between the two systems begin with the function that is assigned to money. It is interesting to note that from an Islamic point of view, money is seen as a medium of exchange rather than a tradable commodity (which is in line with the view of classical economic theory). This leads to the abolition of the predetermined and favorable interest rate. The vital role of the (positive) interest rate in the market vanishes in the Islamic banking system. The view of Islamic banking theory (on money as a medium of exchange only) might not be congruent with the agents acting in the market. Consequently, in order to avoid hoarding, a negative interest rate is set by imposing a wealth tax (t_{SAV}), and cash is canceled out of the system ($C^{NB} = 0$). The non-banks in the system can decide between an investment account that shares the risks and profits of the IBs and a savings account with zero to negative returns. To ensure that hoarding is avoided at all levels of banking, the wealth tax has to be paid besides on savings accounts t_{SAV} also on the excess reserves t_{ER} held by Islamic commercial bank at the Islamic central bank.[101] The tax revenue from the tax rates just mentioned shall be used to redistribute the capital to agents who suffer financial constraints. To account for and simulate the redistribution aspect, heterogeneous agents are introduced (low-income and high-income households, companies, and banks).

Suppose the Islamic banking principles of an interest-free economy are taken "literally", it is crucial to create a heavily dependent system on partnership-based contracts instead of debt-based ones. As a result, the importance of credit markets in the present Islamic banking models must diminish. In the model, credits are given mainly for two reasons.

[100] The Islamic banking system can be called "idealized" because markets in Muslim-majority countries have some form of interest rate. Nevertheless, the presented models are entirely interest-free.

[101] In the author's view the tax on excess reserves in the here developed Islamic banking model as an interpretation of the classic Islamic wealth tax (*zakat*) is a unique contribution to the Islamic banking literature.

First, in the context of "good loans" resulting from the redistributing wealth tax (*zakat*). Second, from the relatively adverse outcomes of the other asset markets, which in the above-presented model consists besides the bond market (which is not explicitly modeled) of the stock or real capital market. Given that through the preference of partnership-based contracts over debt-based contracts, the asset market and its return (dividend yield e) become the dominant force in the market.[102]

It has to be emphasized that the Islamic bond B_{GOV} differs substantially from a conventional bond. B_{GOV} in the model is no debt instrument and has no predetermined part in its return.

In contrast to conventional banks on the asset market, the activity of Islamic commercial banks is limited by legal and moral boundaries (*halal*, *gharar* and *mayseer*). If all these "market interventions" in the Islamic system are taken into account, it is not surprising that market clearance, which is vital to conventional markets, can *not* be reached in all markets at all times. Especially the credit market in the absence of an equilibrium price unsurprisingly exhibits contingent credit volumes.

Another vital aspect of the developed model is the Islamic central bank. The institution has been designed (counter to a conventional central bank) to meet the requirements of a predominant partnership-based system. The Islamic Central Bank ensures liquidity supply through loans S, which the Islamic Central Bank provides if the conventional Islamic bank requires liquidity. Because in this case monetary policy is not possible via favorable interest rates i, the negative interest rate in the form of the respective taxes (t_{ER} and t_{SAV}) are of relevance. The other part of monetary policy, open market operations, differs from standard conventional models. Instead of buying conventional bonds, B, the option is given to purchase stocks A_{ICB} and Islamic government bonds B_{GOV}. In order to have a visual perception of the elucidated open market operation, see figure 2 (see subchapter 3.1).

[102]This is visible in the balance sheets of the model (cf. Table 2).

Keynesian Islamic Banking Models:

The money-credit-stock-market-model is specified in subchapter 3.2 and analyzed in-depth in subchapter 3.3. Thereby, the effects of a rising exogenous monetary base ($dB_m^x > 0$) are shown in subchapter 3.3.1 and a falling tax on excess reserves ($dt_{ER} < 0$) in subchapter 3.3.2. A relatively brief analysis of all other shocks in this model can be found in subchapter 3.3.3. The shock analysis is divided into two effects: the primary (initial impact of the shock parameter) and the secondary (equilibrium price impact) effect.
In the three-markets model, the increase in the monetary base ($dB_m^x > 0$), similar to the conventional model, has overall expansive effects on all three markets. The changes in the stock market trigger the stock market return e; given an excess demand on the stock market, the dividend yield e falls. Thus the stock market converges towards an equilibrium Q_1. Following the increase of B_m^x, the money market faces an excess supply. However, since e is not the equilibrium price of the money market, there is a low probability that the money market ends up in an equilibrium Q_1 in the face of a fall of e. The credit market initially responds similarly to the other markets and comes to an excess supply. The reaction to a fall in e confirms that the credit will not attain an equilibrium (excess supply) in $\overline{Q_1}$. Since it has been already assumed that the Islamic model is driven by equity rather than debt, the decline and rationing in the credit market should be compensated by the strength and importance of the stock market. Nevertheless, a potential Islamic central bank would have to make monetary policy instruments sensitive to possible distortions in the credit market. Particular attention should be paid to the implicit shifts of deposits in the model (D_{SAV} and D_{INV}).
The reduction of the tax on excess reserves ($dt_{ER} < 0$) in a Keynesian Islamic banking model has a contractive effect on the three markets. The stock market initially gets into an excess supply. The disequilibrium stimulates the price, which rises ($de > 0$). The rising dividend yield (e) ensures that demand and supply converge towards the equilibrium point Q_1. The fall in the tax on excess reserves $dt_{ER} < 0$ creates an excess demand on the money market. Again, it must be emphasized that e is not an equilibrium price in this market, hence a rising e may produce an equilibrium in Q_1. The credit market initially responds with excess demand, which exacerbates rationing and excess demand in the market in Q_1 due to the increased e. This instrument (t_{ER}) is strongly inspired by the negative (or penalty) interest rates on excess reserves that the European Central Bank had levied (meanwhile no more) in the context of the credit crunch to stimulate the circulation of capital. A significant difference, however, is that in the Islamic model, tax revenues T_{ER} are used for redistributive purposes in the form of zero-interest loans and transfer payments.This proposal did not yet exist in the modeled

form in the Islamic banking literature. It could be an innovative contribution to moving the classical Islamic approach from a wealth tax (*zakat*) to a practical monetary policy instrument.
Table 4 provides an overview of all shocks that appear in the three-markets model. The central bank credits S, tax on excess reserves t_{ER}, shock parameter ρ, and monetary base B_m^x shock parameter exhibit differences in their economic interpretation but are the same in terms of graphical results. The tax on savings accounts t_{SAV} instead is different, especially given the money market. An equilibrium in both, the money and credit market is not attainable. However, interestingly, a change in t_{SAV} and Y can reduce or even erase a rationing result on the credit market. This shows that a well-coordinated fiscal and monetary policy approach can reduce imbalances in the Islamic Keynesian model. Given this insight, it is essential to extend the three-markets model by a fourth market, namely in the form of an explicit goods market.

A further step in the analysis (in subchapters 3.4 and 3.5) is introducing the explicit goods market explaining output Y endogenously, in order to make the real economic repercussions on real capital (instead of the stock market), money, and credit market visible. An essential feature of the introduced goods market model is that the demand for goods is divided into high-income and low-income parts via heterogeneous agents. Thus, an attempt has been made to implicitly analyze the effect of the Islamic wealth tax on an economy. To the author's knowledge, that is the first attempt to introduce a goods market with heterogeneous agents in the Islamic banking literature. The price of the market changes from e to Tobin's q (that compares the return on new to be produced capital goods R with the return on already produced capital goods r). In order to compare the results from the three-markets model with that of the four-markets model, the same parametrization was taken ($dB_m^x > 0$ and $dt_{ER} < 0$). The analysis was again decomposed into a primary and a secondary effect. The primary effect was nearly the same as the three-markets model, but in the case of the secondary effect, differences in results became apparent.
The positive effect of the increase in the exogenous monetary base ($dB_m^x > 0$) was even accelerated by the income effect and the overall wealth effect. All four markets profited from the increase in Y (positive transfer effect) and in W (wealth effect). Even the transaction volume of the credit market increases ($dK > 0$) which is the only market that falls under the effects of $dB_m^x > 0$ (in the three-markets model). The credit rationing effect positively impacts this shock, as credit constraints loosen somewhat on the credit market.
Then, in contrast to the three-markets model, a risk shock ($d\rho > 0$) occurs, which has the potential to neutralize the positive effects arising from $dB_m^x > 0$. All four markets are affected by the increased risk on credit and stock markets. While in the case of

the positive B_m^x shock, the wealth and income effects amplified the positive effects. An increased risk environment leads to a situation where the mentioned effects amplify the adverse effects. The transition from a three-market model to a four-market model, in short, amplifies the consequences of the shocks. The credit barrier in the credit market is tightening. Therefore there are negative repercussions on the goods market. Due to the increased market risk, agents are expected to switch from D_{INV} (investment deposits) to D_{SAV} (saving deposits), and thus the volume of tax revenues from the tax on savings accounts should increase in the medium term ($dT_{SAV} > 0$), making more transfer payments and zero-interest loans available to low-income agents.

The decrease in tax on excess reserves ($dt_{ER} < 0$) similar to the results in the three-markets model has adverse effects on the four-markets model because more capital is expected to be diverted in order to build up excess reserves ER. Similar to the case of the positive risk shock, an accelerating effect on the negative consequences of lowering the tax (on excess reserves) by considering the goods market is observable. The income Y fell through the income effect $dY < 0$ (negative transfer effect) and through the negative wealth effect. In this case, credit rationing is exacerbated and thus has an additional adverse effect on the goods market. Central banks have also used penalty interest rates as a monetary policy instrument in the wake of the financial crisis to either promote or to curb the circulation of capital, depending on the sign of the tax. Situationally, the central bank may use the volumes of capital dT_{ER} derived from tax revenues to support commercial banks suffering from liquidity shortages through zero-interest loans. In contrast to the three-markets model, the negative effect of $dt_{ER} < 0$ on the markets is even worse.

In Table 5, all shocks hitting the four-markets model are listed. In comparison to the results of the three-markets model (cf. Table 4), it can generally be said that extending the model by the goods market acts as an amplifier on all shocks. That is particularly evident in the credit market, which consistently exhibits the same sign as the rest of the four markets. Another noteworthy difference in the four-markets model is that the money market never reaches equilibrium. An additional significant difference is that the wealth effect and credit rationing constellations create strong feedback effects on markets. However, the heart of the four-markets model is the implicit consequence of the heterogeneity of high-income and low-income companies. In particular, the equations can be used to derive the redistributive implications. These become especially clear in the case of the positive risk shock. In this case, the wealth tax rate (especially t_{SAV}) dampens the negative distributional effects.

New Keynesian Islamic Banking Model:

In chapter 4, the New Keynesian Islamic banking model (NKIBM) is introduced. Since it is known from Keynesian models that equilibrium is unlikely in the money and credit market without a favorable interest rate, endogenous money and credit supply from the three-markets model were incorporated following Offick and Wohltmann (2014). To the author's knowledge, it is the first model in the context of Islamic banking that has been microfounded (cf. subchapter 4.1) based on "Islamic assumptions" and is not formulated ad-hoc. Compared to the Keynesian Islamic banking models, the NKIBM does not include a distinction between different forms of deposits, is based on taxable cash, the wealth tax at the level of excess reserves does not exist, the inflation rate is included, and heterogeneity among non-banks is not assumed.
Subchapter 4.2 contains the static approximation of the NKIBM. The immediate (short-term) effects of the shocks are shown and analyzed. In Table 8, all results of the numerical simulation are listed. The comparison to the Keynesian four-markets model shows that the static model overall confirms the results in the case of db_m^x, $d\rho$, and even the neutralizing effect of the $db_m^x = d\rho$ shock. The substantial difference lies in the effect of the tax on cash t, which in the four-markets model is most closely related to the tax on saving deposits t_{SAV}. An increase in t has contractionary effects on the markets, whereas an increase in t_{SAV} has expansionary effects. This is since, in portfolio theory, t_{SAV} makes investment deposits relatively more attractive by taxing savings deposits. The increased availability of investment capital has a positive effect on all markets. It is not the case in the NKIBM, where tax is exogenous and tax revenue is extracted from the system. In the next step, a comparison with the results of Offick and Wohltmann (2014) has been made. That served as a template for the NKIBM and includes the NKM model with endogenous money and credit supply, but of the conventional kind. The major difference between the models is that in the NKIBM, the credit market always ends up in a rationing result. The conventional NKM model results in equilibrium in all markets due to the market-clearing interest rates. The shocks db_m^x and $d\epsilon_k$ are identical in the signs of results in the NKIBM. $d\pi^T$, $d\epsilon_y$ and the simultaneous shock $db_m^x = d\epsilon_k$ have more substantial differences.

The next step in subchapter 4.3 is analyzing the dynamic NKIBM. There the focus lies at the long-term consequences of a shock. This is particularly relevant because the credit market never reached equilibrium in the static model it must be checked whether the disequilibrium in the dynamic setting is stable over time or equilibrium is achievable even if only for a short period of time. For this purpose, instead of assuming only rational expectations, bounded rational expectations were also included as a possible case. According to the author, the introduction of boundedly rational agents into a dynamic Islamic banking model is the first attempt of its kind. Two shocks are considered, namely the increase in the monetary base b^m_τ and the decrease in the tax on cash t_τ. In doing so, the impulse response functions (IRFs) of the NKIBM with only rational agents with the IRFs from the NKM by Wohltmann and Offick (2014) are compared. On the other hand, the rational IRFs with the ones of the boundedly rational version of the NKIBM.

Comparing the IRFs of the rational version of the NKIBM with the IRFs of the NKM model in the case of an increase in b^m_τ shows that results numerically tend towards the same direction. However, the NKIBM has higher initial jumps, effects of shocks are more persistent, trajectories to steady-state are more volatile, and, as expected, the credit market does not exhibit equilibrium.

In comparing the IRFs under rational behavior with the ones under boundedly rational agents of the dynamic NKIBM, it must be clarified that the boundedly rational version consists of a mix of rational and boundedly rational agents. Hence, different types of expectations are defined according to the value of ϑ. For the comparison between mixed and purely rational agents, the distinction between $\vartheta = 0$ and $\vartheta > 0$ is advantageous for mixed agents.

A rise in b^m_τ exhibits higher initial jumps, higher persistence, and higher volatility compared to pure rational expectations, assuming $\vartheta > 0$ in the mixed agent case. In contrast, it exhibits lower initial jumps, lower persistence, and lower volatility when assuming $\vartheta = 0$ in the case of mixed agents. Interestingly, the credit gap shows a change of sign, which indicates that there is equilibrium in the credit market for a brief moment.

An increase in tax on cash t_τ exhibits higher initial drops, higher volatility, and higher persistence in the case of mixed agents compared to purely rational agents. In the case of the restricted rational agents with a $\vartheta > 1$, it is striking. that the sign of the change in e_τ turns.

Concluding Remarks:

Although this monograph is dedicated to the comparison between Islamic and conventional banking, from the author's point of view, one must resolutely reject any comparisons as to which system is better. There are several reasons for not getting into an ideological dispute by trying to compare banking models.

The first reason is that Islamic banking is currently no more than a theory. Scholars, academics, and professionals from the banking industry overwhelmingly agree that Islamic banking is nowhere near established in any country. Therefore, a comparison with the conventional system would not be appropriate. The representatives of Islamic banking still owe practical evidence for their considerations.

The second reason to refrain from qualitative comparisons is that the proponents of Islamic banking must be given the opportunity to develop their ideas further. In Muslim-dominated countries, there is the desire for a separate identity. Every additional financial crisis strengthens the desire for an "own economic system". As mentioned above, many people regard the prevailing (conventional) economic system as imposed from outside. It is important that the international research community does not evaluate the religious origin of these ideas, but enters into a constructive discourse. One should evaluate the methods and results and point out practical deficits instead of ignoring or even ridiculing the ideas from the outset. This can ensure that actionism and ideology do not dominate the Islamic banking discourse. The author has already noticed the tendency towards actionism and ideology in numerous Islamic banking books and conferences.

Islamic banking re-emerged during the financial crisis of 2007/2008. As stated in the introduction to this monograph, proponents of Islamic banking saw Islamic values with regard to finance as a solution to escalating speculation, betting, and lending. However, the analysis has shown that a financial system that abandons a positive interest rate threatens to provoke rationing and shortages of credit. As the analysis in chapter 3 and 4 have powerfully demonstrated, the negative effects of rationing spill over into the goods market, money market, and stock market. The leverage that credit markets in conventional banking systems create helps the economy to prosper on the one hand, but also carries the risk of bubbles formation on the other hand if it is handled irresponsibly. The transition to a banking system with negative interest rates reduces the importance of the credit market and increases the importance of the equity market (including the stock market). In practice, it would first have to be proven that a zero interest economy can survive in complex and globally interconnected financial systems. The representatives of Islamic finance will either have to present creative and coherent solutions or realize that their vision is impracticable.

Outlook:

In this macroeconomic analysis on Islamic banking, an attempt was made to explain the consensus on the theory behind Islamic banking. To then conceptualize the main differences compared to conventional banking. Based on sharply defined Islamic banking principles, a Keynesian model was formulated which was further developed into a a New Keynesian approach in order to improve the understanding of longer term dynamics. Any attempt to perform this complicated analysis, conducted primarily at the macroeconomic level, is far from being complete. Therefore, an attempt is made to suggest possible extensions and new approaches that could advance Islamic macroeconomic research as a whole. It must be clear that, as repeated several times in the monograph, the goodness of research at the monetary and fiscal levels is mainly dependent on implementation in Muslim-dominated countries. Without the availability of empirical case studies and data, many of the ideas that have been developed in this direction would remain purely theoretical.

The goods market represents a necessary adjusting screw for extending the Islamic Keynesian and New Keynesian model. The IS equation (representative for the goods market) assumes that the supply of goods always corresponds to the demand for goods. This assumption has to be lifted at some point in order to allow rationing on the goods market, too. It would also be helpful to add an investment component to the IS equation in the Islamic New Keynesian model to complete the demand for goods further. Another point in this context would be to look at inequality with the help of separate IS equations, for high-income and low-income non-banks. This attempt has been made in the Keynesian model in this monograph, but not in the New Keynesian setting.

Endogenization of the respective tax rates as policy reaction functions instead of assuming simple exogenous shock processes could be considered. So far, the author has not encountered this type of proposal in model theory within the literature related to the architecture of Islamic monetary systems.

For simplification, it was assumed in the New Keynesian Islamic banking model that the money market, like conventional markets, always ends up in equilibrium. This assumption could also be abandoned, and the repercussions of this step evaluated.

Furthermore, it would also be interesting to see how an economy that is open to international capital movements would behave with regard to potential capital flight. Capital controls or other mechanisms might be suitable instruments and are certainly worth analyzing. As pointed out in the literature review, papers have already looked at the implications of a zero interest rate economy relative to a favorable interest rate economy.

Tokenization is the latest trend in finance and securities law to digitize financial products like crypto-assets. This trend is already being implemented in financing in the areas of real estate and art, for example. According to the author, this innovation offers great opportunities to strengthen investment transactions in Islamic banking. Tokenization makes it possible to divide investment goods into partizons, securitize them, and offer them to smaller investors, too.

From a model-theoretical point of view, there are now first approaches to move away from standard New Keynesian models, which are based on equilibria and contain less heterogeneous agents, in contrast to agent-based models. An excellent starting point would be to look more closely at the work of Dahani et al. (2020) in this context. The agent-based model by Dahani et al. (2020) was formulated with the intention of introducing ethical financial products into the banking system in order to be able to analyze them. Thereby they focus on the impact on consumption, saving, production, and investment within such banking system.

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A Model Appendix

In A.1 to A.6 of the model appendix all crucial steps are shown to derive and analyze the three-markets model, the so called Keynesian Islamic banking model. Thereby in A.1 to A.3 the supply functions of the money market and credit market, and furthermore the demand functions of the stock market are derived from the balance sheets of the Islamic central bank, Islamic bank and Non-banks. Furthermore the appendix focuses on the algebraic analysis of the shock parameters and their implications on the three markets. In chapter A.4 the impact of a a rise in the monetary base and chapter A.5 the impact of fall in tax on excess reserve is calculated.
From chapter A.6 and A.7, the derivation and analysis of the New Keynesian Islamic banking model begins. In A.6, the first-order conditions are derived with respect to consumption, shares, credit and money. Then, in A.7, the credit demand function, money demand function and IS function are presented in log-linearized form.

A.1 Derivation of Supply Function of the Money Market

According to equation (11) from chapter 3.2 and using (12) and (13) it follows:

$$B_m^x + A_{IB} + K + T_{SAV} = M^S \quad \Leftrightarrow \tag{107}$$

$$B_m^x + [a(\cdot) + b(\cdot)]\,(1 + \alpha(\cdot) - t_{SAV})D_{SAV} + T_{SAV} = M^S \quad \Leftrightarrow \tag{108}$$

$$B_m^x + ([a(\cdot) + b(\cdot)]\,(1 + \alpha(\cdot) - t_{SAV}) + t_{SAV})\,D_{SAV} = M^S \tag{109}$$

Now D_{SAV} has to be replaced $(\frac{1}{1+\alpha(\cdot)})M^S$ by:[103]

$$M^S = B_m^x + \left(\frac{([a(\cdot) + b(\cdot)]\,(1 + \alpha(\cdot) - t_{SAV}) + t_{SAV})}{1 + \alpha(\cdot)}\right) M^S \Leftrightarrow \tag{110}$$

$$B_m^x = \left(1 - \frac{([a(\cdot) + b(\cdot)]\,(1 + \alpha(\cdot) - t_{SAV}) + t_{SAV})}{1 + \alpha(\cdot)}\right) M^S \Leftrightarrow \tag{111}$$

$$M^S = \left(\frac{1 + \alpha(\cdot)}{(1 + \alpha(\cdot)) - ([a(\cdot) + b(\cdot)]\,(1 + \alpha(\cdot) - t_{SAV}) + t_{SAV})}\right) B_m^x \Leftrightarrow \tag{112}$$

$$M^S = \left(\frac{1 + \alpha(\cdot)}{(1 + \alpha(\cdot))(1 - [a(\cdot) + b(\cdot)]) + ([a(\cdot) + b(\cdot)] - 1)t_{SAV}}\right) B_m^x \Leftrightarrow \tag{113}$$

$$M^S = \left(\frac{1 + \alpha(\cdot)}{(1 + \alpha(\cdot) - t_{SAV})(1 - [a(\cdot) + b(\cdot)])}\right) B_m^x \Leftrightarrow \tag{114}$$

$$M^S = m^S(\cdot)B_m^x \tag{115}$$

Assuming $[a(\cdot) + b(\cdot)] < 1$ the multiplier $m^S(\cdot)$ is positive ($m^S(\cdot) > 0$).

[103] Equation (3) solved for D_{SAV}.

A.2 Derivation of Supply Function of the Credit Market

The behavioral function of the credit supply is out of the equation (12) from chapter 3.2:

$$K^S = a\left(\overset{(-)}{e}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(+)}{\alpha(\cdot)}, \overset{(-)}{\rho}\right)(1+\alpha(\cdot)-t_{SAV})D_{SAV} \Leftrightarrow \tag{116}$$

Take equation (48) and replace D_{SAV} by $(\frac{1}{1+\alpha(\cdot)})M^S$:

$$K^S = \frac{a(\cdot)(1+\alpha(\cdot)-t_{SAV})}{1+\alpha(\cdot)}M^S \quad \Leftrightarrow \tag{117}$$

$$K^S = \frac{a(\cdot)(1+\alpha(\cdot)-t_{SAV})}{1+\alpha(\cdot)}m^S(\cdot)B_m^x \quad \Leftrightarrow \tag{118}$$

Since for the total amount of money M^S holds $M^S = m^S(\cdot)B_m^x$:

$$K^S = \frac{a(\cdot)(1+\alpha(\cdot)-t_{SAV})}{(1+\alpha(\cdot)-t_{SAV})\cdot(1-[a(\cdot)+b(\cdot)])}B_m^x \quad \Leftrightarrow \tag{119}$$

$$K^S = \frac{a(\cdot)}{(1-[a(\cdot)+b(\cdot)])}B_m^x \tag{120}$$

A.3 Derivation of Demand Function of the Stock Market

According to equation (13) from chapter 3.2, the stock demand of Islamic commercial banks is expressed as:

$$A^D = b\left(\overset{(+)}{e}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(+)}{\alpha(\cdot)}, \overset{(-)}{\rho}\right)(1+\alpha(\cdot)-t_{SAV})D_{SAV} \Leftrightarrow \tag{121}$$

Take equation (47) and replace D_{SAV} by $(\frac{1}{1+\alpha(\cdot)})M^S$:

$$A^D = \frac{b(\cdot)(1+\alpha(\cdot)-t_{SAV})}{1+\alpha(\cdot)}M^S \quad \Leftrightarrow \tag{122}$$

$$A^D = \frac{b(\cdot)(1+\alpha(\cdot)-t_{SAV})}{1+\alpha(\cdot)}m^S(\cdot)B_m^x \quad \Leftrightarrow \tag{123}$$

$$A^D = \frac{b(\cdot)}{(1-[a(\cdot)+b(\cdot)])}B_m^x \quad \Leftrightarrow \tag{124}$$

$$A^D = f^D\left(\overset{(+)}{e}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(+)}{\alpha}, \overset{(-)}{\rho}\right)B_m^x \tag{125}$$

A.4 Algebraic Solution to a $B_m^x \uparrow$ (Three-Markets Model)

The derivation of the algebraic solution begins with the initial equilibrium functions (from chapter 3.2) for the money market (by combining equations (16) and (23)), the credit market (by combining equations (18) and (22)), and the stock market (by combining equations (20) and (21)):

$$\begin{aligned} M_0^S &= m^S\left(\overset{(+)}{e}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}\right) B_m^x \\ &= m^D\left(\overset{(-)}{e}, \overset{(-)}{t_{SAV}}, \overset{(+)}{\rho}, \overset{(+)}{Y}\right) = M_0^D \end{aligned} \tag{126}$$

$$\begin{aligned} K_0^S &= k^S\left(\overset{(-)}{e}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}\right) B_m^x \\ &= k^D\left(\overset{(+)}{e}, \overset{(+)}{Y}\right) = K_0^D \end{aligned} \tag{127}$$

$$\begin{aligned} A_0^S &= P_A\overline{A} = f^S\left(\overset{(-)}{e}\right) \\ &= f^D\left(\overset{(+)}{e}, \overset{(+)}{S}, \overset{(+)}{t_{ER}}, \overset{(+)}{t_{SAV}}, \overset{(-)}{\rho}\right) B_m^x = A_0^D \end{aligned} \tag{128}$$

In the following, the total differential is built for all three markets ((126) to (128)) and transposed in the way that it is visible how the respective markets react to specific changes (in this case $dB_m^x > 0$).
In the first step, calculate how the stock market return e is influenced by the change in the monetary base (dB_m^x). That will result in the respective increase/decrease in the value of stocks, amount of credit, and amount of money.

Stock Market:

According to equation (5) from chapter 3.2, the increase/decrease of the exogenous monetary base is mainly dependent on B_{GOV} and A_{ICB}. In this case, an increase of B_m^x will be implemented by ICB's purchase of B_{GOV} from the government (GOV).

It can be shown that after the initial shock, the stock market will result in a new equilibrium (via the adjustment of e), for which the necessary adjustments are calculated. The partial analysis of de/dB_m^x is calculable with market A (independent of the goods market Y). It is a recursively solvable system. Given the equilibrium condition $A^S = A^D$, the following is attained:

$$
\begin{aligned}
dA^S &= dA^D && \Leftrightarrow && (129)\\
f_e^S de &= \underbrace{f_e^D B_m^x}_{=A_e^D} de + f^D(\cdot) dB_m^x && \Leftrightarrow && (130)\\
(f_e^S - A_e^D) de &= f^D(\cdot) dB_m^x && \Leftrightarrow && (131)
\end{aligned}
$$

In the following set $f_e^S = A_e^S$ then:

$$
\begin{aligned}
de &= \underbrace{f^D(\cdot)}_{>0} \underbrace{\frac{1}{A_e^S - A_e^D}}_{<0} dB_m^x && \Rightarrow && (132)\\
de &< 0 && && (133)
\end{aligned}
$$

After attaining the effect of the change in monetary base on stock market return ($de < 0$), now the change in the value of stocks generated by a change in the monetary base follows:

$$
\begin{aligned}
d\overline{A} &= 0 && \Rightarrow && (134)\\
d(P_A \overline{A}) = \overline{A} dP_A = dA^S &= \underbrace{f_e^S}_{<0} \underbrace{de}_{<0} && && (135)
\end{aligned}
$$

Although the amount of stocks stays constant, due to the rise in P_A, the stocks still rise in value.
Compare with figure 4 (see subchapter 3.3.1) for the change of the equilibrium level of stocks (A_0 to A_1).

Money Market:

Now the final amount of money M has to be determined. Therefore take equation (132) from the stock market and put it into the total differential of the money demand M^D and money supply M^S. First, calculate the effect for the supply side. From (15), it follows:

$$dM^S = \underbrace{m_e^S B_m^x}_{=M_e^S} de + m^S(\cdot) dB_m^x \qquad \Leftrightarrow \qquad (136)$$

$$dM^S = M_e^S \frac{f^D(\cdot)}{A_e^S - A_e^D} dB_m^x + m^S(\cdot) dB_m^x \qquad \Leftrightarrow \qquad (137)$$

$$dM^S = \left[\underbrace{M_e^S}_{>0} \underbrace{\frac{f^D(\cdot)}{A_e^S - A_e^D}}_{<0} + \underbrace{m^S(\cdot)}_{>0} \right] dB_m^x \qquad \Leftrightarrow \qquad (138)$$

$$dM^S \gtrless 0 \qquad (139)$$

For the supply side of the money market, the sign of the change is indeterminate. To calculate the demand side of the money market, again consider equation (132). From (23) (out of chapter 3.2), the following is obtained:

$$dM^D = \underbrace{m_e^D}_{=M_e^D} de \qquad \Leftrightarrow \qquad (140)$$

$$dM^D = \underbrace{M_e^D}_{<0} \underbrace{\frac{f^D(\cdot)}{A_e^S - A_e^D}}_{<0} dB_m^x \qquad \Leftrightarrow \qquad (141)$$

$$dM^D > 0 \qquad (142)$$

It becomes evident that overall the money market (most likely) will **not** end up in an equilibrium. Both excess demand and excess supply are possible. However, there is a possibility of ending up in an equilibrium. The relevant conditions for this case will be calculated in the following. From the equilibrium condition of the money market, it follows that:

$$dM^S = dM^D \qquad \Leftrightarrow \qquad (143)$$

$$\underbrace{m_e^S B_m^x}_{=M_e^S} de + m^S(\cdot) dB_m^x = \underbrace{m_e^D}_{=M_e^D} de \qquad \Leftrightarrow \qquad (144)$$

$$(M_e^S - M_e^D) de = -m^S(\cdot) dB_m^x \qquad \Leftrightarrow \qquad (145)$$

Again, de will be replaced by equation (132).

$$(M_e^S - M_e^D)\frac{f^D(\cdot)}{A_e^S - A_e^D}dB_m^x = -m^S(\cdot)dB_m^x \quad \Leftrightarrow \tag{146}$$

$$\left[\frac{(M_e^S - M_e^D)f^D(\cdot)}{A_e^S - A_e^D} + m^S(\cdot)\right] dB_m^x = 0 \quad \Leftrightarrow \tag{147}$$

$$m^S(\cdot) = \frac{(M_e^S - M_e^D)f^D(\cdot)}{A_e^D - A_e^S} \quad \Leftrightarrow \tag{148}$$

$$\frac{A_e^D - A_e^S}{f^D(\cdot)} = \frac{M_e^S - M_e^D}{m^S(\cdot)} \quad \Leftrightarrow \tag{149}$$

Taking the equations $m^S(\cdot) = \frac{M^S}{B_m^x}$ and $f^D(\cdot) = \frac{A^D}{B_m^x}$ into account the following equation results as a condition for an equilibrium on the money market:

$$\frac{A_e^D - A_e^S}{A^D} = \frac{M_e^S - M_e^D}{M^S} > 0 \tag{150}$$

Equation (150) is a condition that can be further transformed into elasticity functions, which is done later on in the appendix.
Now calculate the conditions which facilitate a rise in the money supply M^S as it can be observed in figure 4 (see subchapter 3.3.1) from M_0 to M_1. It will rise if the following condition (equation (138)) is given:

$$\frac{M_e^S f^D(\cdot)}{A_e^S - A_e^D} + m^S(\cdot) > 0 \tag{151}$$

Again consider $m^S(\cdot) = \frac{M^S}{B_m^x}$ and $f^D(\cdot) = \frac{A^D}{B_m^x}$. Then from (151) you get:

$$dM^S > 0 \Leftrightarrow \frac{M_e^S A^D}{A_e^S - A_e^D} + M^S > 0 \quad \Leftrightarrow \tag{152}$$

$$M^S > -\frac{M_e^S A^D}{A_e^S - A_e^D} \quad \Leftrightarrow \tag{153}$$

$$\frac{M^S}{M_e^S} > \frac{A^D}{A_e^D - A_e^S} \quad \Leftrightarrow \tag{154}$$

Equation (154) can be expressed in terms of elasticities by multiplying e on both sides. Then attain the elasticity of money supply ($\varepsilon_{M^S,e} = \frac{dM^S/M^s}{de/e}$), stock demand elasticity ($\varepsilon_{A^D,e} = \frac{dA^D/A^D}{de/e}$), and stock supply elasticity ($\varepsilon_{A^S,e} = \frac{dA^S/A^S}{de/e}$) are attainded. As in the case of figure 4 it is assumed that the money market is in equilibrium. Since the market for stocks A is always in equilibrium ($dA^D = dA^S$), from (154) the following is attained:

$$\underbrace{\frac{M_e^S}{M^S}e}_{=\varepsilon_{M^S,e}} < \underbrace{\frac{A_e^D - A_e^S}{A^D}e}_{=\varepsilon_{A^D,e}-\varepsilon_{A^S,e}} \tag{155}$$

Equation (155) contains an intuitive assumption that the stock market reacts to its market return e more substantial than the money market on e.
After attaining the elasticity equation, take equation (150) and multiply both sides of the equation by e. Then the final condition for equilibrium in the money market is acquired, which consists of the elasticities:[104]

$$\frac{A_e^D - A_e^S}{A^D}e = \frac{M_e^S - M_e^D}{M^S}e \qquad \Leftrightarrow \tag{156}$$

$$\varepsilon_{A^D,e} - \varepsilon_{A^S,e} = \varepsilon_{M^S,e} - \varepsilon_{M^D,e} \tag{157}$$

Now calculate $\varepsilon_{A^S,e}$[105], then $\varepsilon_{A^S,e} = -1$ is attained:

$$\varepsilon_{A^D,e} + 1 = \varepsilon_{M^S,e} - \varepsilon_{M^D,e} \tag{158}$$

Equation (158) displays the equilibrium condition for the money market (Q_1 in figure 4). Typically, as discussed, the equilibrium is not the only result. Disequilibria are possible if the equilibrium condition (158) is not given. Consequently, the following has to be given in order to get a disequilibrium:

$$\varepsilon_{A^D,e} + 1 \neq \varepsilon_{M^S,e} - \varepsilon_{M^D,e} \tag{159}$$

As it is visible in figure A-1, there are two options for disequilibria. First, an excess supply in the money market. Second, the money market exhibits an excess demand.

[104] $\varepsilon_{M^D,e}$ is calculated at the initial position $M_0^D = M_0^S$. Then $\varepsilon_{M^D,e} = \frac{M_e^D e}{M_0^S(=M_0^D)}$.

[105] $\varepsilon_{A^S,e} = \frac{dA^S/A^S}{de/e} = \frac{dA^S}{de}\frac{e}{A^S} = -\frac{Div\overline{A}}{e^2}\frac{e}{\frac{Div}{e}\overline{A}} = -\frac{Div\overline{A}}{e^2}\frac{e^2}{Div\overline{A}} = -1$

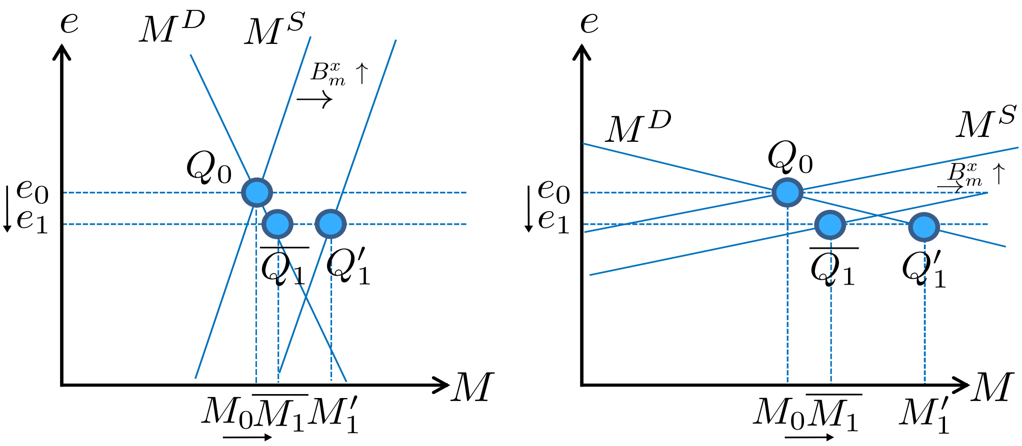

Figure A.-1: Impact of a rise in monetary base on the money market
(lhs: $M^S > M^D$ and rhs: $M^S < M^D$)

<u>Credit Market:</u>

According to the prevailing modified version of the model of the credit market, it is assumed to react to changing of e. It should be remembered that the interest rate (the price of the credit market) is zero. Therefore, in the following, the credit market will react according to the effects on the stock market (consider equation (132), which shows the change in e). The final amount of credit will follow a rationing behavior, explained in the following. In this case, the shorter market side (minimum of total differential of either K^S or K^D) will determine the final transaction volume of the credit market.

$$\min\left\{dK^S; dK^D\right\} \tag{160}$$

$$dK^S = \underbrace{k_e^S B_m^x}_{=K_e^S} de + k^S dB_m^x \quad \Leftrightarrow \tag{161}$$

$$dK^S = \left[\underbrace{K_e^S}_{<0} \underbrace{\frac{f^D(\cdot)}{A_e^S - A_e^D}}_{<0} + \underbrace{k^S(\cdot)}_{>0}\right] dB_m^x \quad \Rightarrow \tag{162}$$

$$dK^S > 0 \tag{163}$$

$$dK^D = \underbrace{k_e^D}_{=K_e^D} de \quad \Leftrightarrow \tag{164}$$

$$dK^D = \underbrace{K_e^D}_{>0} \underbrace{\frac{f^D(\cdot)}{A_e^S - A_e^D}}_{<0} dB_m^x \quad \Rightarrow \tag{165}$$

$$dK^D < 0 \tag{166}$$

After consideration of equation (160), it becomes evident that credit demand K^D determines the transaction volume of the credit market $\overline{K_1}$ (compare with figure 4).

$$dK = dK^D < 0 < dK^S \tag{167}$$

A.5 Algebraic Solution to a $t_{ER} \downarrow$ (Three-Markets Model)

<u>Stock Market:</u>

The total differentiation of the equilibrium condition yields:

$$dA^S = dA^D \qquad \Leftrightarrow \tag{168}$$

$$\underbrace{f_e^S}_{=A_e^S} de = \underbrace{f_e^D B_m^x}_{=A_e^D} de + \underbrace{f_{t_{ER}}^D B_m^x}_{=A_{t_{ER}}^D} dt_{ER} \qquad \Leftrightarrow \tag{169}$$

$$(A_e^S - A_e^D)de = A_{t_{ER}}^D dt_{ER} \qquad \Leftrightarrow \tag{170}$$

$$de = \frac{A_{t_{ER}}^D}{(A_e^S - A_e^D)} dt_{ER} \qquad \Leftrightarrow \tag{171}$$

$$\frac{de}{dt_{ER}} = \underbrace{A_{t_{ER}}^D}_{>0} \underbrace{\frac{1}{A_e^S - A_e^D}}_{<0} \qquad \Rightarrow \tag{172}$$

$$\frac{de}{dt_{ER}} < 0 \tag{173}$$

In subsection 3.3.2 a reduction in t_{ER} is assumed. Hence, consider that (173) has to be multiplied by dt_{ER}:

$$de = \underbrace{\frac{de}{dt_{ER}}}_{<0} \underbrace{dt_{ER}}_{<0} \qquad \Rightarrow \tag{174}$$

$$de > 0 \tag{175}$$

Now take $dt_{ER} < 0$ into account and find out the final amount of stocks:

$$dA = dA^S = \underbrace{f_e^S}_{<0} \underbrace{de}_{>0} \qquad \Leftrightarrow \tag{176}$$

$$dA < 0 \tag{177}$$

Compare the change in the number of stocks with figure 5 (see subchapter 3.3.2).

Money Market:

As $dt_{ER} < 0$ holds, calculation of the change in money supply and demand, following the procedure of (169), leads to:

$$dM^S = \underbrace{m_e^S B_m^x}_{=M_e^S} de + \underbrace{m_{t_{ER}}^S B_m^x}_{=M_{t_{ER}}^S} dt_{ER} \quad \Leftrightarrow \tag{178}$$

$$dM^S = \underbrace{M_e^S de}_{>0} + \underbrace{M_{t_{ER}}^S dt_{ER}}_{<0} \quad \Leftrightarrow \tag{179}$$

$$dM^S \lesseqgtr 0 \tag{180}$$

$$dM^D = \underbrace{m_e^D}_{<0} \underbrace{de}_{>0} \quad \Leftrightarrow \tag{181}$$

$$dM^D < 0 \tag{182}$$

This solution is also observable in figure 5. There, after the initial shifts of the M^S and M^D lines, an excess demand occurs. The subsequent change in $de > 0$, the system converges towards a new equilibrium Q_1 ($dM^D < 0$ and $dM^S < 0$).

$$dM < 0 \tag{183}$$

Although (in figure 5) assumptively, the change in the amount of M has to be smaller than zero algebraically, the change in M^S is undetermined because there is no certainty on whether the change in e brings the money market back into equilibrium or not. The necessary steps to calculate the money market equilibrium conditions are shown below. The total differential of the money market equilibrium yields:

$$dM^S = dM^D \quad \Leftrightarrow \tag{184}$$

$$\underbrace{m_e^S B_m^x}_{M_e^S} de + \underbrace{m_{t_{ER}}^S B_m^x}_{M_{t_{ER}}^S} dt_{ER} = \underbrace{m_e^D}_{M_e^D} de \quad \Leftrightarrow \tag{185}$$

$$(M_e^S - M_e^D) de = -M_{t_{ER}}^S dt_{ER} \quad \Leftrightarrow \tag{186}$$

$$de = -\frac{M_{t_{ER}}^S}{M_e^S - M_e^D} dt_{ER} \quad \Leftrightarrow \tag{187}$$

$$de = \frac{M_{t_{ER}}^S}{M_e^D - M_e^S} dt_{ER} \tag{188}$$

Now substitute de by equation (171):

$$\frac{A^D_{t_{ER}}}{A^S_e - A^D_e} dt_{ER} = \frac{M^S_{t_{ER}}}{M^D_e - M^S_e} dt_{ER} \qquad \Leftrightarrow \tag{189}$$

$$\frac{M^D_e - M^S_e}{M^S_{t_{ER}}} = \frac{A^S_e - A^D_e}{A^D_{t_{ER}}} \tag{190}$$

Equation (190) is the condition that leads the money market into equilibrium. In order to get a condition, which implies disequilibria, a condition for $dM^S > 0$ (since $dM^D < 0$) has to be found. Therefore consider equation (171):

$$M^S_e de + M^S_{t_{ER}} dt_{ER} > 0 \qquad \Leftrightarrow \tag{191}$$

Substitute de for equation (171):

$$M^S_e \frac{A^D_{t_{ER}}}{A^S_e - A^D_e} dt_{ER} + M^S_{t_{ER}} dt_{ER} > 0 \qquad \Leftrightarrow \tag{192}$$

$$M^S_e \frac{A^D_{t_{ER}}}{A^S_e - A^D_e} dt_{ER} > -M^S_{t_{ER}} dt_{ER} \qquad \Leftrightarrow \tag{193}$$

$$\frac{M^S_e}{M^S_{t_{ER}}} > -\frac{A^S_e - A^D_e}{A^D_{t_{ER}}} \qquad \Leftrightarrow \tag{194}$$

$$\frac{M^S_e}{M^S_{t_{ER}}} > \frac{A^D_e - A^S_e}{A^D_{t_{ER}}} \tag{195}$$

Equation (195) is a sufficient condition for a disequilibrium (excess supply) in the money market ($dM^S > 0 > dM^D$). As equation (191) for the case $dM^S < 0$ is considered then three scenarios are possible: $dM^S = dM^D$, $dM^S > dM^D$ and $dM^S < dM^D$. With this information, the condition that typically leads to disequilibria is as follows:

$$\frac{M^D_e - M^S_e}{M^S_{t_{ER}}} \neq \frac{A^S_e - A^D_e}{A^D_{t_{ER}}} \tag{196}$$

Credit market:

Again consider $dt_{ER} < 0$ and the fact that the credit market is not in equilibrium. The transaction volume is given as:

$$dK = \min\left\{dK^S; dK^D\right\} \tag{197}$$

where

$$dK^S = \underbrace{k_e^S B_m^x}_{=K_e^S} de + \underbrace{k_{t_{ER}}^S B_m^x}_{=K_{t_{ER}}^S} dt_{ER} \qquad \Leftrightarrow \tag{198}$$

$$dK^S = \underbrace{K_e^S de}_{<0} + \underbrace{K_{t_{ER}}^S dt_{ER}}_{<0} \qquad \Leftrightarrow \tag{199}$$

$$dK^S < 0 \tag{200}$$

(since $de > 0$ and $dt_{ER} < 0$)

$$dK^D = \underbrace{k_e^D}_{>0} de \qquad \Leftrightarrow \tag{201}$$

$$dK^D > 0 \tag{202}$$

In this rationing setup, the transaction volume of credits is attained by the shorter market side (because of the voluntary nature of the exchange). The credit supply dK^S, in this case, is the determiner. In figure 5, the final amount $\overline{K_1}$ can be observed.

$$dK < 0 \tag{203}$$

A.6 First-Order Conditions

Utility function:

$$U(C_\tau, \frac{M_\tau}{P_\tau}, \frac{K_\tau}{P_\tau}, N_\tau) = \frac{\Xi_\tau^{1-\sigma}}{1-\sigma} - \frac{N_\tau^{1+\eta}}{1+\eta} \tag{204}$$

$$\Xi_\tau = \left[\alpha_1 \cdot C_\tau^{1-v} + \alpha_2 \cdot \left(\frac{M_\tau}{P_\tau}\right)^{1-v} + \alpha_3 \cdot \left(\frac{K_\tau}{P_\tau}\right)^{1-v}\right]^{\frac{1}{1-v}} \tag{205}$$

with Ξ as the preference index of CES-type. Budget constraint:

$$\overbrace{\underbrace{C_\tau}_{\text{consumption}} + \underbrace{\frac{M_\tau}{P_\tau}}_{\text{real balance}} + \underbrace{\frac{M_{\tau-1} \cdot t_{\tau-1}}{P_\tau}}_{\text{tax on cash}} + \underbrace{\frac{A_\tau}{P_\tau}}_{\text{purchase of one period stocks}} + \underbrace{\frac{K_{\tau-1}}{P_\tau}}_{\text{repayment of one period credit}}}^{\text{fund application side}} = \underbrace{\underbrace{\frac{w_\tau}{P_\tau} \cdot N_\tau}_{\text{labor income}} + \underbrace{\frac{A_{\tau-1}}{P_\tau}}_{\text{amount of stocks at the beginning of the period}} + \underbrace{(e_{\tau-1}) \cdot \frac{A_{\tau-1}}{P_\tau}}_{\text{dividend yield}} + \underbrace{\frac{M_{\tau-1}}{P_\tau}}_{\text{amount of cash at the beginning of the period}} + \underbrace{\frac{K_\tau}{P_\tau}}_{\text{received credit}}}_{\text{revenue side}} \tag{206}$$

Set up Lagrangian:

$$\mathcal{L} = E_{\tau+\kappa}\left[\sum_{k=0}^{\infty} \beta^\kappa \left\{U\left(C_{\tau+\kappa}, \frac{M_{\tau+\kappa}}{P_{\tau+\kappa}}, \frac{K_{\tau+\kappa}}{P_{\tau+\kappa}}, N_{\tau+\kappa}\right) + \lambda_\tau \cdot (Y_{\tau+\kappa} - C_{\tau+\kappa})\right\}\right] \tag{207}$$

with $\lambda_{\tau+\kappa}$ as the Lagrange multiplier rewrite (206):

$$\begin{aligned} C_{\tau+\kappa} = (1 - t_{\tau+\kappa-1})\frac{M_{\tau+\kappa-1}}{P_{\tau+\kappa}} - \frac{A_{\tau+\kappa}}{P_{\tau+\kappa}} - \frac{K_{\tau+\kappa-1}}{P_{\tau+\kappa}} + \frac{w_{\tau+\kappa}}{P_{\tau+\kappa}} N_{\tau+\kappa} \\ + (1 + e_{\tau+\kappa-1})\frac{A_{\tau+\kappa-1}}{P_{\tau+\kappa}} - \frac{M_{\tau+\kappa}}{P_{\tau+\kappa}} + \frac{K_{\tau+\kappa}}{P_{\tau+\kappa}} = Y_{\tau+\kappa} \end{aligned} \tag{208}$$

Calculate FOCs with respect to C_τ, A_τ, K_τ, and M_τ are acquired, which lead to the Euler, credit demand, and money demand equations, respectively:

FOC w.r.t. consumption:

$$\frac{\partial \mathcal{L}}{\partial C_\tau} = \frac{\partial U}{\partial C_\tau} - \lambda_\tau \stackrel{!}{=} 0 \tag{209}$$

$$\Xi_\tau^{v-\sigma} \alpha_1 C_\tau^{-v} - \lambda_\tau = 0 \qquad \Leftrightarrow \tag{210}$$

$$\lambda_\tau = \alpha_1 \Xi_\tau^{v-\sigma} C_\tau^{-v} \tag{211}$$

FOC w.r.t. stocks:

$$\frac{\partial \mathcal{L}}{\partial A_\tau} = -\lambda_\tau \frac{1}{P_\tau} + E_\tau \lambda_{\tau+1} \beta(1+e_\tau) \frac{1}{P_{\tau+1}} \overset{!}{=} 0 \tag{212}$$

$$-\lambda_\tau \frac{1}{P_\tau} + E_\tau \left[\frac{\lambda_{\tau+1}}{P_{\tau+1}}\right] \beta(1+e_\tau) = 0 \qquad \Leftrightarrow \tag{213}$$

$$-(\alpha_1 \Xi_\tau^{v-\sigma} C_\tau^{-v}) \frac{1}{P_\tau} + E_\tau \left[(\alpha_1 \Xi_{\tau+1}^{v-\sigma} C_{\tau+1}^{-v}) \frac{1}{P_{\tau+1}}\right] \beta(1+e_\tau) = 0 \qquad \Leftrightarrow \tag{214}$$

$$\alpha_1 \Xi_\tau^{v-\sigma} C_\tau^{-v} \frac{1}{P_\tau} = \alpha_1 E_\tau \left[\Xi_{\tau+1}^{v-\sigma} C_{\tau+1}^{-v} \frac{1}{P_{\tau+1}}\right] \beta(1+e_\tau) \qquad \Leftrightarrow \tag{215}$$

$$\boxed{\frac{1}{1+e_\tau} = \beta E_\tau \left[\left(\frac{\Xi_{\tau+1}}{\Xi_\tau}\right)^{v-\sigma} \left(\frac{C_{\tau+1}}{C_\tau}\right)^{-v} \frac{P_\tau}{P_{\tau+1}}\right]} \tag{216}$$

FOC w.r.t. credits:

$$\frac{\partial \mathcal{L}}{\partial K_\tau} = \left(\frac{K_\tau}{P_\tau}\right)^{-v} \Xi_\tau^{v-\sigma} \alpha_3 \frac{1}{P_\tau} - \lambda_\tau \frac{1}{P_\tau} + \beta E_\tau \left[\frac{\lambda_{\tau+1}}{P_{\tau+1}}\right] \overset{!}{=} 0 \qquad \Leftrightarrow \tag{217}$$

$$\left(\frac{K_\tau}{P_\tau}\right)^{-v} \Xi_\tau^{v-\sigma} \alpha_3 \frac{1}{P_\tau} - \left(\alpha_1 \Xi_\tau^{v-\sigma} C_\tau^{-v}\right) \frac{1}{P_\tau} + \beta E_\tau \left[\left(\alpha_1 \Xi_{\tau+1}^{v-\sigma} C_{\tau+1}^{-v}\right) \frac{1}{P_{\tau+1}}\right] = 0 \qquad \Leftrightarrow \tag{218}$$

$$\left(\frac{K_\tau}{P_\tau}\right)^{-v} \Xi_\tau^{v-\sigma} \alpha_3 \frac{1}{P_\tau} - \left(\alpha_1 \Xi_\tau^{v-\sigma} C_\tau^{-v}\right) \frac{1}{P_\tau} + \frac{1}{1+e_\tau} \Xi_\tau^{v-\sigma} C_\tau^{-v} \frac{1}{P_\tau} \alpha_1 = 0 \qquad \Leftrightarrow \tag{219}$$

$$\left(\frac{K_\tau}{P_\tau}\right)^{-v} \alpha_3 - \alpha_1 C_\tau^{-v} + \frac{1}{1+e_\tau} C_\tau^{-v} \alpha_1 \overset{!}{=} 0 \qquad \Leftrightarrow \tag{220}$$

$$\left(\frac{K_\tau}{P_\tau}\right)^{-v} = \frac{\alpha_1}{\alpha_3} \left(1 - \frac{1}{1+e_\tau}\right) C_\tau^{-v} \qquad \Leftrightarrow \tag{221}$$

$$\boxed{\left(\frac{K_\tau}{P_\tau}\right)^{-v} = \frac{\alpha_1}{\alpha_3} C_\tau^{-v} \frac{e_\tau}{1+e_\tau}} \tag{222}$$

FOC w.r.t. money:

$$\frac{\partial \mathcal{L}}{\partial M_\tau} = \alpha_2 \left(\frac{M_\tau}{P_\tau}\right)^{-v} \Xi_\tau^{v-\sigma} \frac{1}{P_\tau} - \lambda_\tau \frac{1}{P_\tau} + \beta E_\tau \left[\lambda_{\tau+1}(1-t_{\tau+1})\frac{1}{P_{\tau+1}}\right] \overset{!}{=} 0 \tag{223}$$

$$\alpha_2 \left(\frac{M_\tau}{P_\tau}\right)^{-v} \Xi_\tau^{v-\sigma} \frac{1}{P_\tau} - (\alpha_1 \Xi_\tau^{v-\sigma} C_\tau^{-v})\frac{1}{P_\tau}$$

$$+ \beta E_\tau \left[\left(\alpha_1 \Xi_{\tau+1}^{v-\sigma} C_{\tau+1}^{-v}\right) \frac{1}{P_{\tau+1}}\right](1-t_\tau) = 0 \quad \Leftrightarrow \tag{224}$$

$$\alpha_2 \left(\frac{M_\tau}{P_\tau}\right)^{-v} \Xi_\tau^{v-\sigma} \frac{1}{P_\tau} - \alpha_1 \Xi_\tau^{v-\sigma} C_\tau^{-v} \frac{1}{P_\tau}$$

$$+ \frac{1}{1+e_\tau} \Xi_\tau^{v-\sigma} C_\tau^{-v} \frac{1}{P_\tau} \alpha_1 (1-t_\tau) = 0 \quad \Leftrightarrow \tag{225}$$

$$\alpha_2 \left(\frac{M_\tau}{P_\tau}\right)^{-v} - \alpha_1 C_\tau^{-v} + \frac{1-t_\tau}{1+e_\tau} C_\tau^{-v} \alpha_1 = 0 \quad \Leftrightarrow \tag{226}$$

$$\Leftrightarrow \boxed{\left(\frac{M_\tau}{P_\tau}\right)^{-v} = \frac{\alpha_1}{\alpha_2}\left(1 + \frac{1-t_\tau}{1+e_\tau}\right) C_\tau^{-v}} \tag{227}$$

Given the special case $t_\tau = 0$, the money demand function under Islamic banking would equate to the money demand function under conventional banking if additionally the return on stocks e_τ is replaced by the bond interest rate i_τ^B (cf. Offick and Wohltmann (2014) and Lengnick and Wohltmann (2016).

A.7 Log-Linearization

Make use of following notation: $m_\tau = \log M_\tau$, $p_\tau = \log P_\tau$ and $c_\tau = \log C_\tau$ and ignore constants.

Credit demand equation:

$$\left(\frac{K_\tau}{P_\tau}\right)^{-v} = \frac{\alpha_1}{\alpha_3} C_\tau^{-v} \frac{e_\tau}{1+e_\tau} \tag{228}$$

$$-v\left(k_\tau - p_\tau\right) = -vc_\tau + \log\left(\frac{e_\tau}{1+e_\tau}\right) \tag{229}$$

Taylor approximation

$$\log\left(\frac{e_\tau}{1+e_\tau}\right) \approx \log\left(\frac{\bar{e}_0}{1+\bar{e}_0}\right) + \frac{1+\bar{e}_0}{\bar{e}_0} \cdot \frac{1}{(1+\bar{e}_0)^2} \cdot (e_\tau - \bar{e}_0) \tag{230}$$

gives

$$k_\tau - p_\tau = c_\tau - \frac{1}{v} \cdot \frac{1}{\bar{e}_0(1+\bar{e}_0)} \cdot (e_\tau - \bar{e}_0) \tag{231}$$

$$\Leftrightarrow k_\tau - p_\tau = c_\tau - \frac{1}{v} \cdot \frac{1}{1+\bar{e}_0} \cdot \frac{(e_\tau - \bar{e}_0)}{\bar{e}_0} \tag{232}$$

$$\Leftrightarrow k_\tau - p_\tau = c_\tau - \frac{\beta^2}{v(1-\beta)}(e_\tau - \bar{e}_0) \tag{233}$$

where $\beta = \frac{1}{1+\bar{e}_0}$ and $\bar{e}_0 = \frac{1-\beta}{\beta}$.

Money demand equation:

$$\left(\frac{M_\tau}{P_\tau}\right)^{-v} = \frac{\alpha_1}{\alpha_2} C_\tau^{-v} \left(1 + \frac{1-t_\tau}{1+e_\tau}\right) \tag{234}$$

$$\Leftrightarrow -v(m_\tau - p_\tau) = -vc_\tau + \log\left(1 + \frac{1-t_\tau}{1+e_\tau}\right) \tag{235}$$

where the Taylor approximation

$$\begin{aligned}\log\left(\frac{1-t_\tau}{1+e_\tau}\right) \approx & \log\left(\frac{1-\bar{t}_0}{1+\bar{e}_0}\right) + \frac{1+\bar{e}_0}{1-\bar{t}_0} \cdot \frac{1}{1+\bar{e}_0} \cdot (t_\tau - \bar{t}_0) \\ & + \frac{1+\bar{e}_0}{1-\bar{t}_0} \cdot \frac{1-\bar{t}_0}{(1+\bar{e}_0)^2} \cdot (e_\tau - \bar{e}_0)\end{aligned} \tag{236}$$

gives

$$m_\tau - p_\tau = c_\tau - \frac{1}{v} \cdot \left(\frac{1}{1-\bar{t}_0} \cdot (t_\tau - \bar{t}_0) + \frac{1}{1+\bar{e}_0}(e_\tau - \bar{e}_0) \right) \tag{237}$$

<u>Euler equation:</u>

Rewrite (216):

$$\beta \frac{1+e_\tau}{E_\tau\left(\frac{P_{\tau+1}-P_\tau}{P_\tau}+1\right)} E_\tau \left\{ \left(\frac{\Xi_{\tau+1}}{\Xi_\tau}\right)^{v-\sigma} \left(\frac{C_{\tau+1}}{C_\tau}\right)^{v-\sigma} \left(\frac{C_{\tau+1}}{C_\tau}\right)^{-\sigma} \right\} = 1 \tag{238}$$

and log-linearize it, resulting in:

$$\begin{aligned} & e_\tau - E_\tau(\pi_{\tau+1}) - \bar{e}_0 + (v-\sigma)(E_\tau(x_{\tau+1}) - x_\tau) \\ & - (v-\sigma)(E_\tau(c_{\tau+1}) - c_\tau) - \sigma(E_\tau(c_{\tau+1} - c_\tau)) = 0 \qquad (239) \\ \Leftrightarrow & \sigma \cdot c_\tau = \sigma E_\tau c_{\tau+1} - (e_\tau - E_\tau(\pi_{\tau+1}) - \bar{e}_0) \\ & + (v-\sigma)\{E_\tau(c_{\tau+1} - x_{\tau+1}) - (c_\tau - x_\tau)\} \qquad (240) \end{aligned}$$

where $\pi_{\tau+1} = \frac{P_{\tau+1}-P_\tau}{P_\tau}$. Since

$$\begin{aligned} x_\tau &= \frac{d\Xi_\tau}{\bar{\Xi}_0} = \bar{\Xi}_0^{v-1}\{\alpha_1 \bar{C}_0^{-1-v} c_\tau + \alpha_2 \left(\frac{\bar{M}_0}{\bar{P}_0}\right)^{1-v} (m_\tau - p_\tau) \\ & + \alpha_3 \left(\frac{\bar{K}_0}{\bar{P}_0}\right)^{1-v} (k_\tau - p_\tau)\} \Leftrightarrow \qquad (241) \\ x_\tau &= \frac{1}{\bar{\Xi}_0^{1-v}} \Bigg\{ \alpha_1 \bar{C}_0^{1-v} c_\tau + \alpha_2 \left(\frac{\bar{M}_0}{\bar{P}_0}\right)^{1-v} (c_\tau - \frac{1}{v} \cdot (\frac{1}{1-\bar{t}_0} \cdot (t_\tau - \bar{t}_0) \\ & + \frac{1}{1+\bar{e}_0}(e_\tau - \bar{e}_0))) \\ & + \alpha_3 \left(\frac{\bar{K}_0}{\bar{P}_0}\right)^{1-v} (c_\tau - \frac{\beta^2}{v(1-\beta)}(e_\tau - \bar{e}_0)) \Bigg\} \qquad (242) \end{aligned}$$

Now, first exclude and then cancel out $\bar{\Xi}_0^{1-v}$:

$$
\begin{aligned}
\Leftrightarrow x_\tau = & \frac{1}{\bar{\Xi}_0^{1-v}} \underbrace{\left\{ \alpha_1 \bar{C}_0^{1-v} + \alpha_2 \left(\frac{\bar{M}_0}{\bar{P}_0} \right)^{1-v} + \alpha_3 \left(\frac{\bar{K}_0}{\bar{P}_0} \right)^{1-v} \right\}}_{=\bar{\Xi}_0^{1-v}} c_\tau \\
& - \frac{1}{\bar{\Xi}_0^{1-v}} \frac{1}{v} \left\{ \alpha_3 \frac{\beta^2}{1-\beta} \left(\frac{\bar{K}_0}{\bar{P}_0} \right)^{1-v} + \alpha_2 \frac{1}{(1+\bar{e}_0)} \left(\frac{\bar{M}_0}{\bar{P}_0} \right)^{1-v} \right\} (e_\tau - \bar{e}_0) \\
& - \frac{1}{\bar{\Xi}_0^{1-v}} \frac{1}{v} \alpha_2 \frac{1}{1-\bar{t}_0} \left(\frac{\bar{M}_0}{\bar{P}_0} \right)^{1-v} (t_\tau - \bar{t}_0) \qquad (243) \\
\Leftrightarrow x_\tau = & \, c_\tau - X_1 (e_\tau - \bar{e}_0) - X_2 (t_\tau - \bar{t}_0) \qquad (244)
\end{aligned}
$$

and X_1 and X_2 are taken out of equation (240):

$$
X_1 = \frac{1}{\bar{\Xi}_0^{1-v}} \frac{1}{v} \left\{ \alpha_3 \frac{\beta^2}{1-\beta} \left(\frac{\bar{K}_0}{\bar{P}_0} \right)^{1-v} + \alpha_2 \frac{1}{(1+\bar{e}_0)} \left(\frac{\bar{M}_0}{\bar{P}_0} \right)^{1-v} \right\} \qquad (245)
$$

$$
X_2 = \frac{1}{\bar{\Xi}_0}^{1-v} \frac{1}{v} \alpha_2 \frac{1}{1-\bar{t}_0} \left(\frac{\bar{M}_0}{\bar{P}_0} \right)^{1-v} \qquad (246)
$$

implying

$$
c_\tau - x_\tau = X_1 (e_\tau - \bar{e}_0) + X_2 (t_\tau - \bar{t}_0) \qquad (247)
$$

Then isolate c_τ and put it into the already log-linearized Euler equation:

$$
c_\tau = E_\tau c_{\tau+1} - \frac{1}{\sigma} (e_\tau - E_\tau(\pi_{\tau+1}) - e_0) + \frac{v-\sigma}{\sigma} E_\tau \Delta (c_{\tau+1} - x_{\tau+1}) \qquad (248)
$$

$$
\Leftrightarrow c_\tau = E_\tau c_{\tau+1} - \frac{1}{\sigma} (e_\tau - E_\tau(\pi_{\tau+1}) - e_0) + \frac{v-\sigma}{\sigma} \left\{ X_1 E_\tau \Delta e_{\tau+1} + X_2 \Delta t_{\tau+1} \right\} \qquad (249)
$$

Declaration

Erklärung zum selbständigen Verfassen der Arbeit:

Ich erkläre hiermit, dass ich meine Doktorarbeit "*The Difference between Islamic and Conventional Banking: A Basic Macroeconomic Approach*" selbstständig und ohne fremde Hilfe angefertigt habe und dass ich alle von anderen Autoren wörtlich übernommenen Stellen, wie auch die sich an die Gedanken anderer Autoren eng anlehnenden Ausführungen meiner Arbeit, besonders gekennzeichnet und die Quellen nach den mir angegebenen Richtlinien zitiert habe.

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